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ERRATA.

Page 397, line 4 from bottom, and p. 409, line 19 from top, *read* Mr. G. Brook *and not* "Brooks."

— 411, line 18 from bottom, the letter *v* in "*vulgaire*" has dropped out.

— 446, top line, *for* "MEGALOPREPRIA" *read* "MEGALOPREPIA."

— 541, line 13 from bottom, for "*uticulus*" read "*utricului*."

THE JOURNAL

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Revision of the *Idoteidæ*, a Family of Sessile-eyed Crustacea.

By Edward J. Miers, F.L.S., F.Z.S.

[Read June 16, 1881.]

(Plates I.–III.)

In the account now laid before the Society of this interesting group I have, as in previous memoirs*, restricted myself to the endeavour to elucidate the classification, definition, and distribution of the genera and species, which had become greatly confused in consequence of the large additions to the literature of recent years. Hence, it appeared, a revision was urgently needed.

Introductory Remarks on the History and Classification of the Idoteidæ.

Little need be said, by way of introduction, regarding the classifications employed by the earlier authors (such, for instance, as Leach†, Desmarest‡, and Risso§), since the types with which they were acquainted were but few, and the definitions of the generic divisions employed by them are not generally of sufficient importance to allow of their employment in a natural system of classification.

* Revision of the *Hippidea* in Journ. Linn. Soc. Zool. xiv. pp. 312–336 (1878). On the *Squillidæ*, Ann. & Mag. Nat. Hist. (ser. 5) v. pp. 1 and 108 (1880).

† Trans. Linn. Soc. xi. pp. 353, 364 (1815).

‡ 'Considérations générales sur les Crustacés,' p. 288 (1825).

§ 'Hist. naturelle de l'Europe méridionale,' v. p. 107 (1826).

Latreille, in 1829*, divided the Isopoda into six sections, and included in his fourth section (*Idotéides*, Leach) the three genera *Idotea*, *Stenosoma*, and *Arcturus*.

Milne-Edwards, in 1840†, in his great work, united under the designation *Idotéides* the three genera *Arcturus*, *Idotea*, and *Anthura*, including in *Idotea* the various genera proposed by Leach and Risso, and placed *Idotea* and *Anthura* in his subtribe *Idotéides ordinaires*. As, however, Harger has recently shown, *Idotea* has in reality a much closer affinity with *Arcturus* than with *Anthura*. The sectional divisions adopted by Milne-Edwards, based upon the number of postabdominal segments and the structure of the epimera, afforded excellent characters for distinguishing the species in the then existing state of carcinological knowledge.

But fifteen species are enumerated by Milne-Edwards, and of these several are now shown to have been based upon characters insufficient to distinguish them from their congeners; but others, which later authors have proved to be distinct, are referred to in the notes.

Dana (in 1853) in his final classification of the Isopoda in his work on the Crustacea of the U.S. Exploring Expedition‡, enumerated five genera in the family *Idoteidæ*, but of these two are apparently insufficiently characterized. He associated the *Idoteidæ* with the *Chætiliidæ* in his subtribe *Idotæidea*, but removed the *Arcturidæ* to the Anisopoda (a group in some measure analogous to the Anomura among the stalk-eyed Crustacea), where they form, with the *Anthurinæ*, a distinct subtribe, *Anisopoda Idotæica*.

In Messrs. Spence Bate and Westwood's standard work on the British Edriophthalmia§ will be found a very complete account of the British species, accompanied by well-executed figures, and prefaced by an account of the principal anatomical and morphological characters of the *Idoteidæ*. In the system of classification adopted by these authors, the *Idoteidæ* are associated with the *Arcturidæ* among the non-parasitic water-breathing Isopoda, much as in Latreille's classification, and are far removed from the *Anthuridæ*.

One of the most important and valuable contributions to our knowledge of the subject since the publication of the 'Histoire

* In Cuvier, Règne Animal (ed. 2), iv. p. 131 (1829).

† 'Hist. naturelle des Crustacés,' iii. p. 121 (1840).

‡ Crust. in U.S. Explor. Expedition, xiv. p. 697 (1853).

§ 'A History of British Sessile-eyed Crustacea,' ii. pp. 114, 375 (1868).

naturelle des Crustacés' is Mr. Harger's memoir on the Marine Isopoda of New England and the adjacent waters*.

Here will be found not only a very full and, I believe, accurate account of the principal structural characters of the group, but also detailed descriptions, accompanied by excellent figures in outline, of all the genera and species inhabiting the eastern coast of the Northern United States, together with much new information regarding their geographical distribution, and a most useful bibliographical list of the principal works relating to the literature of the subject.

I regret that I have frequently been unable to adopt Mr. Harger's nomenclature, since a comparative study of the *Idoteidæ* from all parts of the globe has necessitated the union of several of the genera and species described by him with other previously-known types; but my obligations to his work will appear throughout the present memoir, and to it I must refer the student for further information on the structure of the buccal and sexual organs, and other points in the history of such species as inhabit the region of which it treats.

In Mr. Harger's classification the *Idoteidæ* are associated with the *Arcturidæ*.

In the present revision forty-seven species (besides several varieties) are enumerated, distributed into four genera.

Much additional value has been given to this memoir by an act of generous liberality on the part of Prof. Alph. Milne-Edwards, who, hearing that I was engaged on a revision of the *Idoteidæ*, immediately placed at my disposal for examination the rich collection of species of this group belonging to the Muséum d'Histoire naturelle of Paris, containing the types of Prof. H. Milne-Edwards's descriptions in the 'Histoire naturelle des Crustacés;' also specimens of the Algerian species described by M. Lucas, and others of which I had previously seen no specimens. Thus I have not only been able to identify the specimens in the Museum collection by actual comparison with the French types, but also to redescribe the latter with the additional detail rendered necessary by the large increase in the number of genera and species in this family.

I am also indebted to the Rev. A. M. Norman (who kindly lent me two important memoirs which otherwise I could not have

* Report of the U.S. Fish and Fisheries Commissioner for 1878 (pt. vi. 1880).

consulted), the Rev. T. R. R. Stebbing, Prof. S. Lovén, and others for assistance and information.

Whenever possible, I have taken my descriptions from typical or well-authenticated specimens of each species. In not a few cases, however, where no specimens have been available for examination, or where the material has been insufficient, the description has been taken wholly or in part from a previous author; such alterations being usually made as are necessary to ensure uniformity in the terminology employed and in the sequence of the parts described. Thus, wherever possible, the several segments of the body are *first* described, and afterwards their appendages in regular succession, whereby it is hoped the comparison of allied species will be facilitated. The difficulty of verifying the very numerous references to the synonyms has been great, and there still remain certain publications which I have been unable to consult; but these are not referred to unless the original citation was made upon good authority.

IDOTEIDÆ.

Idotéides, *M.-Edw.* (*part.*), *Hist. Nat. Crust.* iii. p. 121 (1840).
Idotæinæ, *Dana, Amer. Journ. Sci. and Arts* (ser. 2) viii. p. 426 (1849).
Idotæidæ, *Dana, Amer. Journ. Sci. and Arts* (ser. 2) xiv. p. 300 (1852); *id. U.S. Expl. Exp.* xiv. (*Crust.* ii.) p. 697 (1853).
Idoteidæ, *S. Bate and Westwood, Brit. Sessile-eyed Crust.* ii. p. 375 (1868); *Miers, Cat. New-Zeal. Crust.* p. 91 (1876); *Harger, Isopoda in Rep. U.S. Fish Comm.* (part vi.) p. 335 (1880).

The *Idoteidæ* comprised in this revision correspond to the genus *Idotea* of Milne-Edwards and to the *Idoteidæ* of Dana, Messrs. Bate and Westwood, Harger, and other authors, and may be characterized as follows:—Body ovate or oblong, or more or less oblong-ovate; head and thoracic segments distinct; postabdomen with some or all of its segments consolidated into a large terminal scutiform piece. Eyes usually lateral, but sometimes placed on the dorsal surface of the head. Antennules four-jointed and usually shorter than the antennæ, which have a five-jointed peduncle and terminate in a flagellum, which may be short, rudimentary, or composed of a single joint, or (more usually) multi-articulated. Mandibles non-palpigerous; maxillipedes operculiform. Legs usually subsimilar in form, the three anterior pairs directed forward; but in *Glyptonotus* the first three pairs ter-

minate in a subprehensile hand formed by the flexion of the terminal joint or dactylus upon the more or less dilated penultimate joint or propus. The first five pairs of postabdominal appendages are delicate and membranaceous, and are covered by the operculum, which is specially characteristic of this family. The operculum is composed of the greatly elongated and dilated bases and the interior rami of the posterior pair of postabdominal appendages or uropoda, which constitute a pair of longitudinally folding doors, closing over the ventral surface of the postabdomen; the exterior rami are also occasionally present as small lamellæ articulating with the basal plates of the operculum.

The *Idoteidæ* are found in all parts of the globe, but appear to be more abundant in the temperate and colder seas than in the tropics. They occur usually at moderate depths along the coast and often amid the seaweed, on either sandy, muddy, or rocky bottoms. Some species also may occur at considerable depths: thus *Glyptonotus entomon* has been taken at a depth of 60 fathoms in the Baltic (Möbius), and *Edotia nodulosa* at 190 fathoms off Halifax (Harger). *Idotea metallica* is a pelagic species found upon the surface of the ocean, or amid floating seaweed at great distances from the land, and other species are occasionally found under similar conditions. Although generally marine, certain species inhabit freshwater lakes; instances are the *G. entomon*, which occurs in the deep Scandinavian lakes Wener and Wettern (Prof. Lovén), and *Idotea lacustris*, which has been found in a freshwater lagoon in New Zealand by Mr. Thomson, and with which I identify, though with great hesitation, specimens, probably marine, from Port Henry, Magellan Strait, in the Museum collection.

The nearest affinities of the *Idoteidæ* are with the *Arcturidæ* and with the *Chætiliidæ* of Prof. Dana—a group founded for the reception of the single genus and species *Chætilia ovata*. As no description is given of the buccal organs and of the five anterior pairs of legs in *Chætilia*, it is impossible for me to express any opinion as to whether it should really be retained in a distinct family from the *Idoteidæ*. The multiarticulate character of the sixth and seventh pairs of thoracic legs is probably not a character of the importance assigned to it by Dana.

In its ovate form, four-segmented postabdomen, and elongated antennules the relationship of *Chætilia* to *Glyptonotus* is obvious; but the antennules in *Chætilia* are placed immediately above the antennæ, as in *Edotia*.

No less apparent is the relationship of the *Idoteidæ* to the *Arcturidæ*; the two families, as Harger has pointed out, resemble one another in the structure of the cephalic appendages, partially consolidated postabdominal segments, and operculiform uropoda. This affinity is most strikingly exemplified in comparing *Arcturus* with the genus *Idotea*. The *Arcturidæ* are distinguished principally by their robust and elongated antennæ, and by having the four anterior pairs of thoracic legs directed forward and fringed with long and flexible hairs. Whether they will be finally associated with the *Idotæidæ*, or whether it will prove to be practically more convenient to retain Dana's threefold division of the Edriophthalmia into *Isopoda*, *Anisopoda*, and *Amphipoda* (when the *Arcturidæ* must be regarded as *Anisopoda Idotæica*), remains to be determined by whomsoever shall undertake the classification of the whole of the genera of the Edriophthalmia*.

The following are diagnostic characters of the subfamilies and genera as limited in the present revision:—

Subfam. I. GLYPTONOTINÆ.

Sides of the head emarginate or cleft, and laterally produced beyond the eyes, which thus are situated upon its dorsal surface. The three anterior pairs of legs with the penultimate joint or propus dilated, and forming, with the reflexible dactylus, a prehensile hand.

Body ovate, with some or all of the epimera distinct in a dorsal view, and considerably developed. Postabdomen composed of four or five distinct segments. Antennal flagellum distinct.

GLYPTONOTUS.

Subfam. II. IDOTEINÆ.

Sides of the head not laterally produced, entire. Eyes lateral. Legs all ambulatory; the three anterior pairs with the penultimate joint not dilated.

Body oblong-ovate, with the epimera distinct and more or less evident in a dorsal view. Postabdomen composed of one to five distinct segments. Antennæ with a multiarticulated flagellum.

IDOTEA.

* Prof. Claus, in the French translation by Prof. Moquin-Tandon of his 'Grundzüge der Zoologie,' p. 465 (1871), includes both *Chætilia* and *Arcturus* in his *Idotéides*.

Body ovate, with the epimera not distinctly separated by a suture from the thoracic segments. Postabdomen nearly always uniarticulate. Antennæ with the flagellum rudimentary, few-jointed, or multiarticulated. Basal opercular plates with an oblique line crossing their outer surface. EDOTIA.

Body slender and more or less oblong-ovate, with the epimera small but distinct, and some or all evident in a dorsal view. Postabdomen composed of one to five distinct segments. Antennæ with the joints of the flagellum consolidated into a single piece. CLEANTIS.

These four genera appear to me to indicate the natural groups into which the family may be subdivided; but it must be noted that (as in all classifications) species in some degree intermediate occur. Thus in *Idotea prismatica* the flagellar segments of the antennæ are occasionally partially consolidated, and this species in many other of its characters approaches very nearly to *Cleantis*; and in *Idotea hectica* the epimera are not distinct, yet in its three-jointed postabdomen and in all other characters this species belongs to *Idotea* rather than to *Edotia*.

The principal characters for distinguishing the species of this group are to be found in the form and the degree of convexity and tuberculation of the segments of the body, the relative length of the antennæ and of their constituent joints, and similar structural details; the coloration, although occasionally characteristic, is not apparently generally to be relied upon as of great importance in the classification †.

LIST OF THE GENERA AND SPECIES.

IDOTEIDÆ.

Subfam. GLYPTONOTINÆ.

GLYPTONOTUS.

*1. *G. antarcticus*, Eights. New South Shetlands.
2. *G. entomon* (Linn.). Baltic and circumpolar seas.
3. *G. Sabini* (Kröyer). Boreal and circumpolar seas.
4. *G. cæcus* (Say). East coast of U. States; Nova Scotia.
*5. *G. Tuftsii* (Stimpson). East coast of U. States; Nova Scotia.

† For some very interesting remarks on the influence of the light in effecting change of colour in the *Idoteidæ* (confirmatory of previous observations by Pouchet and Jourdain on other Crustacea), see Dr. Paul Mayer, in Mittheil. Zool. Stat. Naples, i. p. 521 (1879).

Subfam. IDOTEINÆ.

IDOTEA.

1. *I. prismatica* (Risso). Mediterranean; shores of the English Channel.
*2. *I. mediterranea* (Risso). Mediterranean.
3. *I. Whymperi*, Miers. North Atlantic.
*4. *I. Danai*?, Miers. Rio de Janeiro, Brazil.
5. *I. marina* (Linn.). Mediterranean, Black and Caspian Seas, German Ocean, coasts of Great Britain, Scandinavia; E. coast of U. States, Brazil, New Zealand, Australia, Red Sea, Java?
5*a*. *I. marina*, var. *phosphorea*, Harger. E. coast of U. States; Scandinavia?
6. *I. ochotensis*, Brandt. N.E. coast of Asia; W. coast of America to California.
*7. *I. urotoma*, Stimpson. California.
*8. *I. gracillima* (Dana). California.
9. *I. metallica*, Bosc. Almost cosmopolitan; pelagic.
*10. *I. margaritacea*, Dana. N. S. Wales, Port Jackson.
*11. *I. pustulata* (Risso). Mediterranean.
12. *I. lacustris*, Thomson. New Zealand; Magellan Straits?
13. *I. Wosnesenskii*, Brandt. Sea of Ochotsk and Kamtchatka, along W. coast of N. America to California.
14. *I. Whitei*, Stimpson. California.
15. *I. emarginata* (Fabr.). Mediterranean, Britain, Denmark, and S. Scandinavia.
16. *I. resecata*, Stimpson. California.
17. *I. hectica* (Pallas). Mediterranean, Atlantic; Bourbon?
18. *I. linearis* (Linn.). Mediterranean, Britain, Denmark, Scandinavia, Canaries?, Java?
19. *I. indica*, M.-Edwards. Malabar.
20. *I. ungulata* (Pallas). Austral circumpolar or Antarctic region, Indian Ocean; C. of Good Hope; coasts of S. America northward to Rio de Janeiro and Talcahuano.
21. *I. elongata*, White (*ined.*), Miers. Auckland and Falkland Islands.
22. *I. Peronii*, M.-Edw. Coasts of Australia, Tasmania, C. of Good Hope.
23. *I. lobata*, White (*ined.*), Miers. —— ?
24. *I. carinata*, Lucas. Mediterranean, Algeria.
25. *I. acuminata* (Leach). Mediterranean, Adriatic and Black Seas; coasts of Britain.
25*a*. *I. acuminata*, var. *lanciformis*, Risso. Mediterranean.
25*b*. — ————, var. *appendiculata* (Risso). Mediterranean.
25*c*. — ————, var. *lancifer*, Leach (*ined.*). S. Britain.
26. *I. stricta*, Dana. Australia, N. S. Wales.
27. *I. longicaudata* (S. Bate). S. Australia, G. of St. Vincent.
*28. *I. Lichtensteinii*, Krauss. C. of Good Hope.

EDOTIA.

1. *Edotia bicuspida* (Owen). Boreal circumpolar region; E. coast of N. America southward to G. St. Lawrence.
2. *E. nodulosa* (Kröyer). Boreal circumpolar region; coasts of N. America southward to Brit. Columbia and Newfoundland.
3. *E. hirtipes* (M.-Edw.). S. Africa.
3*a*. — ————, var. *lævidorsalis*, Miers. Japan, Jatiyama Bay.
4. *E. triloba* (Say). E. coast of U. States.

*5. *E. montosa* (Stimpson). E. coast of N. America.
5*a*. — ———, var. *hirsuta* (Harger). Whitney River.
6. *E. tuberculata*, Guérin-Méněville. Sts. of Magellan and Falklands.
7. *E. magellanica*, Cunningham. Sts. of Magellan.
*8. *E.* ? *chilensis* (Gay). Chile.

Cleantis.

*1. *C.* (*Erichsonia*) *angulata* (Dana). Rio de Janeiro.
2. *C.* (*E.*) *filiformis* (Say). New Jersey, Massachusetts; Gloria (Brazil ?).
*3. *C.* (*E.*) *attenuata* (Harger). New Jersey, Connecticut.
4. *C.* (*Cleantis*) *isopus*, Grube (*ined.*). Cheefoo, Ojica, Goto Island.
*5. *C.* (*C.*) *linearis*, Dana. N. Patagonia, Rio Negro.
*6. *C.* (*C.*) *granulosa*, Heller. St. Paul.

The species marked with an asterisk are those of which I have seen no specimens, and several of these are very probably insufficiently characterized (for further information on this head see under the several species). The following may be mentioned, however, as very doubtfully distinct:—*Idotea margaritacea*, *I. pustulata*, *I. stricta*, *Edotia montosa*. Large though the number be of supposed species now reduced to the rank of synonyma, it is probable that future workers will add others to the list.

Subfamily I. GLYPTONOTINÆ.

Sides of the head emarginate or cleft, and laterally produced beyond the eyes, which thus are situated upon its dorsal surface. The three anterior pairs of legs with the penultimate joint or propus dilated and forming, with the reflexible dactylus, a prehensile hand.

Species more or less ovate.

This subfamily includes the single genus

Glyptonotus.

Glyptonotus, *Eights*, "*Trans. Albany Instit.* ii. p. 331, pls. (1833–52);" *id. Amer. Journ. of Sci. & Arts* (ser. 2) xv. p. 135 (1853); *id. Ann. & Mag. Nat. Hist.* xi. p. 339 (1853); *id. Amer. Journ. of Sci. & Arts*, xxii. p. 391, pls. ii., iii. (1856).

Idotæga, *Lockington, Pr. Cal. Acad. Sci.* (pt. i.) vii. p. 44 (1877).

Chiridotea, *Harger, Amer. Journ. of Sci. & Arts*, xv. p. 374 (1878); *Marine Isopoda of New England in Rep. U.S. Comm. of Fish and Fisheries* (pt. vi.), p. 337 (1880).

? Saussureana, *Haller*, "*Mitth. schweiz. ent. Ges.* v. p. 573 (1879)."

Body moderately convex and more or less ovate, broadest at the third or fourth thoracic segments, with the sides thence con-

vergent to the subacute distal extremity of the postabdomen. Head enlarged; its lateral margins divided by a suture into two lobes, behind which the eyes are situated. Postabdomen large, consisting of four or five distinct segments. Antennules somewhat elongated. Antennæ rather short, but with a well-developed articulated flagellum. Mandibles robust. Maxillipedes with a 3–5-jointed palpus. Epimera considerably developed, and some or all evident in a dorsal view, the posterior three pairs prolonged backward at their acute postero-lateral angles. Legs robust; those of the three anterior pairs thrown forward, with the dactylus reflexible and the penultimate joints or palms dilated, the dilatation usually greatest in the first pair. Operculum with the basal plates marked with a raised line running close to and nearly parallel with the inner margins, but without an oblique line on their outer surface; beneath the terminal plates is a very small oval lamella, which is the outer ramus of the modified uropoda.

Mr. Harger, in his description of *Chiridotea*, first indicated the natural limits of this genus, and that it would include the long-known *Idotea entomon* and *I. Sabini* (Am. J. Sci. & Arts, xv. p. 374, 1878). By many, and even some recent, authorities these species, notwithstanding their obvious distinctness from other members of the family, have been included in the genus *Idotea*.

I have not been able to consult Haller's description of *Saussureana*, and the citation of this genus as synonymous with *Glyptonotus* must be considered doubtful. According to the generic diagnosis quoted by Dr. Bertkau (Archiv f. Naturgesch. xlvi. p. 271, 1880), the three anterior thoracic legs are chelate, body linear (an approach to this form is exhibited in young *G. Sabini*). The species, which its author does not name, only differs from *Glyptonotus* in its very short antennæ, and is from Labrador.

In its geographical range *Glyptonotus* appears to be confined to the colder temperate, arctic, and antarctic seas.

The species of this genus may be distinguished as follows:—

a. *Epimera distinct only on the three posterior segments.*

Thoracic segments with a median line of tubercles; terminal postabdominal segment longitudinally carinated.

1. *G. antarcticus*, Eights.

b. *Epimera on the second to seventh segments distinct.*

* *Species large, elongate-ovate; outer ramus of uropoda (or opercular valves) minute.*

Joints of the peduncle of the antennæ not dilated; flagellum 8-14-jointed; antero-lateral cervical lobes prominent.

2. *G. entomon* (Linn.).

Joints and peduncle of antennæ greatly dilated; flagellum 7–8-jointed; antero-lateral cervical lobes not prominent.

3. *G. Sabini* (Kröyer)?

** *Species small, orbiculate-ovate; outer ramus of uropoda at least half as long as the inner.*

Antennæ little longer than the antennules; flagellum about 7-jointed; eyes inconspicuous. 4. *G. cæcus* (Say).

Antennæ about twice as long as the antennules; flagellum about 12-jointed. Eyes usually distinct.

5. *G. Tuftsii* (Stimpson).

GLYPTONOTUS ANTARCTICUS.

Glyptonotus antarcticus, *Eights*, "*Trans. Albany Instit.* ii. p. 331, pls. (1833–52)"; *Amer. Journ. of Sci. & Arts* (ser. 2) xv. p. 135 (1853), xxii. p. 391, pls. ii., iii. (1856); *Ann. & Mag. Nat. Hist.* xi. p. 339 (1853).

The head (according to Dr. Eights, from whose long description and figures the following is adapted) is transversely elliptical, its superior surface is ornamented with an imperfectly sculptured "*fleur-de-lis*," its posterior portion obtusely elevated, producing a marginal rim; in the middle of the anterior margin there is a small notch. The segments of the thorax are beautifully sculptured on their upper surface, and, together with the post-abdominal segments, are each armed with a median, angular, and elongated knob, which, when united, form a prominent dorsal ridge, gradually diminishing in its backward course, and forming a sharp elevated line along the terminal segment, terminating at its extremity in a short and obtusely-pointed spine. The thoracic segments are bordered along their posterior margins by an elevated and continuous marginal rim, extending to the lateral extremities of the shell. The postabdomen is composed of five segments; the four anterior are much smaller than those of the thorax, but greatly resemble them in form, being ornamented on their superior surfaces with similar insculptations, though but slightly defined; the fourth segment (as shown in the figure) is much broader than the base of the terminal segment, and its

postero-lateral angles are greatly prolonged and acute; the terminal segment is large and triangular, and, as appears from the figure, is obtusely pointed at its distal extremity. Eyes small, reniform, indigo-blue, placed near the lateral and anterior margin of the head. Antennules half the length of the antennæ, three-jointed, and terminating in an attenuated filament (flagellum), whose articulations are indistinct. Antennæ corresponding in length to the width of the head, transversely from spine to spine (exclusive of flagellum?); peduncular joints four in number, the last the longest; flagellum about the length of the peduncle, multiarticulated (joints over twenty in the figure). The epimera are distinguishable in a dorsal view on the three posterior thoracic segments only (in the figure they are large, with acute postero-lateral angles). The three anterior legs project forward, the dactyli being incurved upon the edges of the rather largely-inflated penultimate joints; the four posterior legs are directed backward, and are strongly triangulate, stout, and ponderous, terminating with a slightly curved nail; their length is nearly equal, but they gradually increase in thickness as they recede towards the tail. The basal joints are large and inflated, the remainder regularly angulate; the extremities of the articulating joints and edges of the two inferior angles are each provided with a series of tufted and rigid spines. The biarticulated opercular valves are of a triangulate form, each having near its termination a small oval articulation. Colour brown-sepia. Length from the insertion of the antennæ $3\frac{1}{2}$ inches (nearly 90 millim.); width $1\frac{3}{4}$ inch (nearly 45 millim.).

This gigantic species inhabits the shores of the New South Shetlands. According to Dr. Eights, it inhabits the bottom of the sea, and is only to be obtained when thrown far upon the shores by the immense surges that prevail when the detached glaciers from the land precipitate themselves into the ocean. I have seen no specimens.

Although distinguished from the arctic species by the non-distinctness of the three anterior epimera, the longitudinal median line of dorsal tubercles, and other characters, it cannot, I think, be regarded as generically distinct.

GLYPTONOTUS ENTOMON. (Plate I. figs. 1 & 2.)

Oniscus entomon, *Linn. Syst. Nat.* (ed. xii.) ii. p. 1060 (1766); *Pallas, Spicil. Zool.* ix. (fasc. 9) p. 64, pl. v. figs. 1–6 (1772).

"? Entomon pyramidale, *Klein, Rem. sur les Crustacés,* figs. 1–3."

Squilla entomon, *De Geer, Mém. pour servir à l'Hist. des Insectes,* vii. p. 514, pl. xxxii. figs. 1–10 (1778).

Asellus entomon, *Olivier, Encycl. Méth.* p. 253 (1789).

? Cymothoa entomon, *Fabr. Ent. Syst.* ii. p. 505 (1793).

? Asellus entomon, *Olivier, Encycl. Méth.* iv. p. 253 (1789).

Idotea entomon, *Bosc, Hist. Nat. des Crust.* ii. p. 178 (1802); ? *Latr. Hist. Nat. Crust. et Ins.* vi. p. 361, vii. pl. lviii. figs. 2, 3 (1803–4); ? *Lamarck, Hist. des Anim. sans Vert.* (ed. i.) v. p. 159 (1818); ? *Sabine, Appendix in Parry's Arctic Voy.* p. ccxxviii (1821); ? *Ross, Zool. in Parry's 3rd Voy.* p. 117 (1826); ? *Desm. Consid. Cr.* p. 289 (1825); ? *Eichwald,* "*Geogn. zool. per Ingriam marisque Baltici provincias obs.* pl. v. fig. 1"; *Rathke,* "*Neuste Schriften der naturf. Gesellsch. in Danzig,* i. p. 109, pl. iv. (1820)"; *Kröyer, Vid. Selsk. Skrift.* vii. p. 323 (1838); *M.-Edwards, Hist. Nat. Crust.* iii. p. 128 (1840)?; *Kröyer, Nat. Tidsskr.* ii. p. 402 (1847); *White, List Cr. Brit. Mus.* p. 93 (1847); *Brandt, Cr. in Middendorff's Sibirische Reise,* ii. p. 145 (1851); *Lovén, Œfvers. Vetensk.-Akad. Förhandl. Stockholm,* xviii. p. 286 (1852); *Bell, in Belcher's Last of the Arctic Voyages,* i. p. 408 (1855)?; *Lindström, Œfv. Vet.-Akad. Förhandl.* p. 66 (1856); *Haughton, Proc. Nat. Hist. Soc. Dublin,* iv. p. 61 (1865); *Möbius, Ann. & Mag. Nat. Hist.* ser. 4, xii. p. 84 (1873); *Cajander, Cr. in Notiser Fauna & Flora Fennica,* p. 374 (1869); *Meinert, Nat. Tidsskr.* (3 R.) xi. p. 84 (1877); *Brandt, Comptes Rendus,* p. 713 (1880); *id. Ann. & Mag. Nat. Hist.* vi. p. 98 (1880).

? Saduria entomon, *Adams, in White, Sutherland's Voy. Baffin's Bay, &c. Appendix,* p. ccvii (1852).

Idotæga longicauda, *Lockington, Pr. Cal. Acad. Sci.* vii. (pt. i.) p. 45 (1877).

In the specimens I refer to this species the body is ovate, moderately convex, with a more or less faintly-indicated median carina, and posteriorly much elongated. Head anteriorly deeply excavated, its anterior margin with a median sinus, its antero-lateral lobes rounded or subtruncated, its anterior margin slightly thickened on each side of the median sinus. The three anterior segments have each a slight elevation in the middle line, and another on each side, but at some distance from the lateral margins (these are most distinct in the younger individuals); the first segment is widest at the lateral margins. The post-abdomen is longer than the thorax, with the first four segments distinct but very short; terminal segment smooth, with the sides convergent to the distal extremity, which usually curves upward and is blunt or subacute; the median longitudinal dorsal carina is more distinctly indicated on this segment than on the rest of the

body. Eyes small, often indistinct or obsolete. Antennules about reaching to the end of the antennal peduncle, with the basal joint thickened and the rest slender and elongated. Antennæ with the penultimate joint of the peduncle rather small and not dilated; last joint longer than the preceding, flattened above, but not dilated as in *Idotea Sabini*; flagellum about 8–14-jointed. Epimera of all the segments broad, with the postero-lateral angles acute, and in the fourth to seventh segments considerably prolonged backward. Legs (in the adult) very robust; the palmar or penultimate joint of the first three pairs dilated, but narrowed at the apex, where it is articulated with the slender dactylus; the four posterior pairs considerably elongated (the posterior pair reaching, when retracted, beyond the end of the postabdomen), with the joints, except the dactylus, thickened, with more or less hairy margins. Terminal valves of the operculum very small and narrow; in an adult example scarcely one fifth the length of the preceding. Length of the largest specimen in the Museum about 3 inches (77 millim.), breadth rather more than $1\frac{1}{3}$ inch (35 millim.).

This species occurs in the Baltic, and not improbably throughout the Arctic and circumpolar seas; also in the depths of the Swedish lakes (Prof. Lovén).

Specimens are in the collection of the British Museum from the following localities:—An adult and four young examples from the "Northern Seas" (*Old Collection*, preserved dry); an adult and younger example (dry) from the Cattegat (the Rev. Prof. Haughton); two examples (dry) from the Baltic (Prof. Lovén); two small examples in imperfect condition from the Banksian Collection, one of which bears the designation *Saduria entomon* in, I believe, Dr. Leach's handwriting. A fine adult example, sent by Mr. Lockington, under the name of "*Idotæga alaskensis*," and labelled as coming from Behring's Straits, cannot be distinguished specifically from the foregoing. It is probably a male, but the second pair of postabdominal appendages are without stylets.

In the collection entrusted to me for examination by Prof. Alph. Milne-Edwards, and containing the types of the Paris Museum, is a male of rather small size from Sweden (Dr. Malm), and labelled as inhabiting "*les eaux douces*."

In none of the specimens I have examined is an incubatory pouch developed.

Idotea entomon occurs, according to Grimm, Zeitsch. f. wiss. Zool. xxv. p. 324 (1875), in great abundance in the Caspian Sea; but it does not appear, from this author's note, whether this is the species here described as *G. entomon*.

There is a specimen, labelled *entomon*, of this species in the Linnean Cabinet in the possession of the Linnean Society; hence there can be little doubt that this is the true *entomon* of Linnæus. It is certainly the species so designated by Pallas, since he figures the last two joints of the peduncle of the antennæ of the elongated, less dilated form characteristic of our Baltic examples.

The *Idoteé vitée*, Bosc (Hist. Nat. Crust. ii. p. 180, 1802) (*Idotea vittata*, Latr.) has the body composed of ten segments, of a grey colour punctated with brown, with a broad yellow band on the back; tail elongated and pointed. It is allied, according to Latreille, to *Idotea entomon*, but is scarcely 3½ lines in length, and the segments are without lateral appendages (epimera?). On account of the last-mentioned character, I doubt if it should be referred to this genus. It was found in the open sea.

Glyptonotus Sabini. (Plate I. figs. 3–5.)

? Idotea Sabini, *Kröyer, Nat. Tidsskr.* (2 R.) ii. p. 401 (1847); *Atlas of Crust. in Gaimard's Voy. en Scand.* pl. xxvii. fig. 1; *Reinhardt, Fortegnelse over Grönlands Krebsdyr*, p. 34 (1857); *Lütken, List of Crust. of Greenland in Arctic Manual*, p. 149 (1875); *Sars, Arch. f. Math. og Naturvidensk.* ii. p. 350 (1877); var., *Heller, Denkschr. der Akad. Wien*, xxxv. p. 38 (1878).

? Chiridothea megalura, *G. O. Sars, Archiv f. Math. og Naturvidenskab.* iv. p. 432 (1880).

In this species the body is narrower and more elongated than in *G. entomon*, and the postero-lateral angles of the first segment and of the epimera of the second segment are not so much prolonged backward and are less acute. The terminal postabdominal segment appears to be firmly ankylosed with the fourth, and is sinuated on the sides at the base, and again at a point rather more than halfway to the apex, which is slightly recurved. The penultimate and terminal joints of the peduncle of the antennæ are flattened above and considerably dilated, with the margins cristiform and acute; the flagellum 7–8-jointed. The largest specimen I have seen is about $3\frac{1}{6}$ inches long (80 millim.), and rather more than $1\frac{1}{12}$ inch broad (29 millim.).

I doubt whether the characters assigned to the *Chiridothea*

megalura of Sars can be regarded as of specific importance. In most of the specimens I refer to *G. Sabini* the greatest width of the terminal postabdominal segment slightly exceeds half its length.

The materials at my disposal are insufficient to determine the geographical range of this species, which, like the preceding, appears to be confined to high Northern and Arctic latitudes. There are in the collection of the British Museum an adult male from Davis Straits (Dr. Sutherland), in which, as the specimen is preserved in spirits, I have been able to ascertain that the styliform appendages of the second pair of postabdominal appendages are fully developed; a smaller male from the Haslar Hospital Collection, also with fully-developed stylets; two adult males from Repulse Bay, N. America (Dr. Rae, preserved dry); also an adult female with fully-developed incubatory pouch, from Riscoe (Disco?), Davis Straits, collected in lat. 67° 10′ N.

A specimen whose particular locality is unfortunately unknown, but which was contained in a jar with other species supposed to come from some point on the W. coast of N. America, also probably belongs to this species; but the epimera of the second to fourth segments are not so deep in proportion to their length as in the other examples.

A young example obtained near Picton Rock Glacier (Dr. Sutherland) resembles the adult in the general outline of the body; the epimera of the three posterior thoracic segments, however, are somewhat slenderer and more elongated. There is an open notch at the sides of the head. The joints of the peduncle of the antennæ are dilated, as in the adult; those of the flagellum are not distinguishable. Length $\frac{7}{12}$ inch (15 millim.); greatest breadth about 5 millim. Its slenderer and more elongated form, and the dilatation of the peduncular joints of the antennæ, thus clearly distinguish this species, even in its young condition, from *G. cæcus*. (See Plate I. fig. 2*b*.)

Glyptonotus Sabini occurs in a subfossil state in Greenland, according to Prof. S. Lovén (see Nordenskiöld in Arctic Manual, p. 410, 1875).

It is not improbable that many of the earlier writers may have confounded this species and *G. entomon*, or referred to *G. Sabini* under the Linnean name.

I refer the Museum specimens with some doubt to Kröyer's species, because in his diagnosis he makes no mention of that

which is certainly their most marked distinctive character, *i. e.* the considerable dilatation of the peduncular joints of the antennæ, nor does his figure represent these joints as much dilated as in the specimens before me; moreover, the characters of the antennulary joints and of the anterior thoracic legs do not entirely correspond; but these points are probably of minor importance. His species corresponds with ours in its more elongated form, shorter antennal flagellum, and, as the figure shows, in the less prominent antero-lateral lobe of the head. Should, however, the specimens in the Museum collection prove to be distinct, they may probably be designated by Sars's specific name *megalura*. Heller, it may be added, in his remarks upon this species, in his account of the Crustacea collected by the Austrian Expedition to the North Pole, adheres to Kröyer's diagnosis.

GLYPTONOTUS CÆCUS.

Idotea cæca, *Say, Journ. Ac. Nat. Sci. Phil.* i. p. 424 (1818); *Hitchcock, Rep. Geol. Mass.* p. 29 (1833); *Gould, Invert. of Massachusetts*, p. 337 (1841); *M.-Edw. Hist. Nat. Crust.* iii. p. 131 (1840); *DeKay, Zool. New York Fauna*, vi., *Cr.* p. 42 (1844); *White, List Cr. Brit. Mus.* p. 94 (1847); *Verrill, Rep. U.S. Commiss. of Fish & Fisheries*, i. p. 340 (1874); *Harger, Rep. U.S. Commiss. of Fish & Fisheries*, i. p. 569, pl. v. fig. 22 (1874).

Chiridotea cæca, *Harger, Am. Journ. Sci. & Arts*, (ser. 3) xv. p. 374 (1878); *id. Pr. U.S. Nat. Mus.* ii. p. 159 (1879); *id. Rep. U.S. Commiss. of Fish & Fisheries*, vi. p. 338, pl. iv. figs. 16–19 (1880).

The body is very broadly ovate, narrowing rapidly posteriorly. Head but slightly excavated in front for the bases of the antennæ, and with a more or less open notch at the sides extending nearly to the eyes; the breadth of the thorax is greater than its length, and the length of the segments is greater on the sides than in the median line; the postabdomen is convex above, with the first three segments very short, the fourth indicated only by lateral sutures, and united in the dorsal region with the terminal segment, which is ovate-lanceolate, scarcely sinuated on the sides, and acute at the distal end; the eyes are light-coloured and inconspicuous. Antennules longer than the peduncle of the antennæ. Antennæ with the peduncular joints of moderate length, not much dilated; flagellum about 7-jointed. Epimera with the postero-lateral angles acute, but not greatly prolonged backward. The three anterior pairs of legs have the propus or penultimate joint dilated, the dilatation being greatest in the first pair, and the

dactylus completely reflexible. The four posterior legs are similar in form, with non-dilated penultimate joints, and clothed with bristly hairs. The stylet on the second pair of postabdominal appendages is elongated and curved at the tip. The terminal plates of the opercular valves are small and not acute at the apices. The colour of this species is variable, but usually dark greyish, with lateral mottlings of light yellowish grey. Its length does not exceed $\frac{2}{3}$ inch (12–16 mm.), and breadth $\frac{1}{3}$ inch (6–8 mm.).

The description is almost entirely taken from Mr. Harger's valuable report.

Its range extends along the eastern shores of North America as far south, according to Say, as Florida, and northward to Nova Scotia, it having been obtained at Halifax in 1877 by the naturalists of the U.S. Fish Commission. There are in the British-Museum collection five small, and now imperfect, examples of this species, presented by Thomas Say.

Glyptonotus Tuftsii.

Idotea Tuftsii, *Stimpson, Marine Invert. Great Manan*, p. 39 (1853); *Verrill, Pr. Amer. Assoc.* p. 362 (1874); *id. Rep. U.S. Commiss. of Fish & Fisheries*, i. p. 340 (1874); *Harger, Rep. U.S. Commiss. of Fish & Fisheries*, i. p. 569 (1874).

Chiridotea Tuftsii, *Harger, Am. Journ. of Sci. & Arts*, (ser. 3) xv. p. 374 (1878); *id. Proc. U.S. Nat. Mus.* ii. p. 159 (1879); *id. Rep. U.S. Commiss. of Fish & Fisheries*, vi. p. 340, pls. iv. & v. figs. 20–23 (1880).

This species, of which I have seen no specimens, is, according to Mr. Harger, distinguished from the preceding by its smaller size and longer antennæ, the joints of the peduncle of which are slenderer than in *G. cæcus*, the fifth as long as the third and fourth together; the flagellum about 12-jointed, longer than the peduncle, and tapering from the base. The antennules are slender, and do not surpass the peduncle of the antennæ. The incision in the produced lateral margin of the head is nearly closed by the overlapping of the antero-lateral lobe.

The length scarcely exceeds $\frac{1}{3}$ inch (9 mm.), breadth $\frac{1}{6}$ inch (4–5 mm.).

It has been taken at various localities on the eastern coast of Nova Scotia and the United States, *e.g.* at Halifax, in the Bay of Fundy, on the coast of Maine and Massachusetts (in considerable abundance), and in Long Island Sound. For further particulars see Harger's often-cited Report on the Marine Isopoda of

New England &c., in the sixth part of the Report of the U.S. Fish Commission (1880).

The *Æga Harfordi* of Lockington (Pr. Cal. Acad. Sci. p. 46, 1877) is designated *Idotæa Harfordi* in a MS. note of the author, and the short description would apply in most particulars to a species of *Glyptonotus*. Specimens, however, are in the British Museum from Sta. Rosa Island, received from Mr. Lockington, which certainly do not belong to any genus of *Idoteidæ*, but to *Cirolana* or a closely allied type. Can it be that two distinct species were confounded under one name?

Subfamily II. IDOTEINÆ.

Sides of the head in a dorsal view entire and not laterally produced. Eyes lateral. Legs all ambulatory; the three anterior pairs with the penultimate joint not dilated.

The species are ovate or (more usually) more or less oblong-ovate, or slender and linear, and none attain so bulky a size as do certain of the species of *Glyptonotus*.

Idotea.

Idotea, *Fabr.* (*part.*) *Ent. Syst. Suppl.* p. 302 (1798); *Latr.* (*part.*) *Hist. Nat. Crust. et Ins.* vi. p. 560 (1803); *Lamarck, Hist. des Anim. sans Vert.* v. p. 160 (1818); *Leach* (*part.*), *Trans. Linn. Soc.* xi. pp. 353, 364 (1815); *Desm. Consid. Crust.* p 288 (1825); *M.-Edw.* (*part.*) *Hist. Nat. Crust.* iii. p. 125 (1840); *Dana* (*part.*), *Amer. Journ. of Sci. & Arts*, (ser. 2) xiv. p. 300 (1852); *id. U.S. Expl. Exp.* xiv., *Cr.* ii. p. 697 (1853); *Bate & Westwood* (*part.*), *Hist. Brit. Sessile-eyed Crust.* ii. p. 376 (1868); *Harger, Marine Isopoda, in Rep. U.S. Fish Commission*, pt. vi. p. 341 (1880).

Stenosoma, *Leach, Trans. Linn. Soc.* xi. pp. 353, 366 (1815); *Desm. Consid. Crust.* p. 290 (1825).

Leptosoma (*Leach, MS.*), *Risso, Hist. Nat. Eur. mérid.* v. p. 107 (1826).

Zenobia, *Risso, t. c.* p. 110 (1826).

Armida, *Risso, t. c.* p. 109 (1826).

Crabyzos, *S. Bate, Proc. Zool. Soc.* p. 504 (1863).

Body moderately convex, more or less elongated, and oblong-oval. Head with the sides not laterally produced and bilobated. Postabdomen consisting of one to five segments, rarely uniarticulate, but with lateral sutures indicative of one or more additional, partially coalescent, segments. Eyes placed close to the lateral margins. Antennules small. Antennæ elongated, with a well-

developed and multiarticulate flagellum. Palpi of the maxillipedes four-jointed, the last composed of two coalescent joints. Epimera well developed and evident in a dorsal view, but not greatly elongated, as in *Glyptonotus*. Legs with the dactyli more or less reflexible, but with the penultimate joint not considerably dilated as in *Glyptonotus*. Operculum with the basal plates usually marked with a raised line running close to and nearly parallel with the inner margins, but without an oblique line as in *Edotia* *, each bearing at its distal end a strong plumose bristle, which is concealed by the terminal opercular plate.

The species of this genus are distributed throughout the world, but occur but very rarely in the highest latitudes.

Leach's designation of *Stenosoma* has been adopted by some subsequent authors for certain species of *Idotea*. The original diagnosis, however, does not permit even of its being used for a sectional designation in the present revision. *Leptosoma*, on the other hand, will include all *Idoteæ* with a uniarticulate postabdomen. *Armida* of Risso may probably include the typical *Idoteæ* with three-jointed postabdomen and indications of a fourth, partially coalescent, segment, although he says, "*abdomen quadriarticulatus.*"

The genus *Hebe*, included by Risso among his Idoteadées, is obviously very inaccurately characterized; but on account of the short antennæ and subulate postabdominal appendages can hardly belong to any of the European members of this family, but may perhaps be referred to the *Anthuridæ*. In the single species (*H. punctata*) the third pair of legs are three times as long as the rest.

I. *Postabdomen composed of four or five distinct segments, visible in a dorsal view.* (*Species small or minute, with a few-jointed antennal flagellum.*) Zenobia?

This section is established provisionally for certain species, two of which are of minute size, and may possibly be young forms; but as I have not seen any young examples presenting similar characters, I have thought it better, for the present at least, to consider them distinct. Risso, it may be noted, makes no mention of the few-jointed antennal flagellum in *Zenobia*; but this character exists in specimens, which I have scarcely any doubt are rightly referred to his *Z. prismatica*, in the Paris collection.

* Faint traces of an oblique line are, however, observable in *I. Wosnesenskii*.

The following characters will apparently suffice to distinguish the species referred to this section:—

* *Terminal segment wider at base than the preceding segments.*

Terminal segment subtriangulate, with the angles rounded. 1. *I. Whymperi*, Miers.

** *Terminal segment not wider at base than the preceding.*

Rounded at the distal end. 2. *I. prismatica* (Risso).

Feebly emarginate at the distal end. 3. *I. mediterranea* (Risso).

Subangulated at the distal end. 4. *I. Danai*, Miers.

IDOTEA PRISMATICA.

Zenobia prismatica, *Risso, Hist. Nat. Eur. mérid.* v. p. 111, pl. v. fig. 24 (1826); *Lucas, Anim. artic. in Expl. Sci. Algérie*, p. 63 (1849); *Hope, Cat. Cr. Ital.* p. 27 (1851).

Idotea chelipes, *Costa, Faun. Reg. Napoli, Cr.* pl. xi. fig. 2 (1838); *Hope, Catal. Crust.* p. 26 (1851); *nec Fabr., nec Latr.*

Idotea prismatica, *Heller, Verh. zool.-bot. Gesellsch. Wien*, xvi. p. 729 (1866); *Stalio, Att. Istit. Venet.* (ser. 5) iii. p. 1354 (1876–77).

Idotea parallela, *S. Bate & Westwood, Brit. Sessile-eyed Crust.* ii. p. 391, fig. (1868); *Stebbing, Rep. Devon Assoc.* vi. p. 772 (1874).

The body is convex, narrow, and elongated, with the sides parallel and the dorsal surface smooth. Head with its anterior margin nearly straight, but feebly emarginate in the middle. First thoracic segment with small rounded antero-lateral lobes which do not reach to the eyes; all the thoracic segments with their anterior and posterior margins nearly straight, their postero-lateral angles rounded in the first three segments, and not at all produced in the following segments. Postabdomen with four distinct segments, the three first very short, the fourth nearly twice as long as broad, with lateral sutures indicative of a coalescent segment near its base, its distal extremity semicircularly rounded and entire, and the dorsal surface flat in its distal half and subobliquely deflexed. Eyes black, nearly linear, and transverse. Antennules short, four-jointed, the basal joint but moderately dilated. Antennæ not exceeding one third the length of the animal; peduncle five-jointed, the first joint very short, the fourth and fifth subequal; flagellum with five or six distinct joints, of which the first is very short, the second longest (apparently composed of two coalescent joints), the rest short, the last being minute and concealed by a pencil of short stiff hairs. Legs

slender, small, and of nearly equal length, the first, however, being more robust. Epimera narrow, not reaching, in the second to fourth segments, quite to the postero-lateral angles of the segments; in the fifth to seventh segments the epimera are acute and prolonged backward beyond the thoracic segments. Opercular valves with their distal plates small, rounded off at their posterior and external angles. The colour (according to M. Risso) of the body is olive-green, with a longitudinal median and two lateral blackish lines; all the segments with scattered punctulations; postabdomen of an opaque grey. Antennæ annulated with white and brown; legs yellowish. Length of the largest male I have examined about $\frac{7}{12}$ inch (15 mm.); but many of the specimens are much smaller.

This species inhabits the shores of the Mediterranean and Adriatic, and its range extends northward to the shores of the English Channel.

The description (except as regards colour) and measurements are taken from specimens in the collection of the Paris Museum, which, I doubt not, are correctly referred to this species, and of which two have been obtained (in exchange) for the British Museum. M. Risso's description and figure would lead one to suppose that the jointed flagellum is absent; and it is evident from the description of Messrs. Bate and Westwood that the joints are sometimes imperfectly defined. Dr. Heller particularly mentions the existence of a short 3–5-jointed flagellum in specimens from Lesina. There are in the Paris collection seven specimens (males and females) from Bona (M. Lucas).

The Rev. A. M. Norman kindly sent to me for examination a specimen of *I. parallela* from Paignton, S. Devon, presented to him by the Rev. T. R. R. Stebbing, which places the correctness of the identification of the British species with the Mediterranean *I. prismatica* beyond a doubt. In it, however, the articulations of the flagella of the antennæ are scarcely distinguishable; and, as I have already noted, Bate and Westwood in their description mention the partial consolidation of these joints. In most, if not all, of the specimens from the Mediterranean the joints of the flagellum are perfectly distinct.

IDOTEA ? MEDITERRANEA.

Zenobia mediterranea, *Risso, Hist. Nat. Eur. mérid.* v. p. 111 (1826); *Hope, Cat. Cr. Ital.* p. 27 (1851).

Differs from the preceding, according to M. Risso, only by its

smoother, more shining body, which is of an olive-green colour, with fine longitudinal olive-brown lines, and which is covered with more widely scattered punctulations; the antennæ and legs are of a clear grey, and the terminal postabdominal segment is feebly emarginated. Length nearly $\frac{1}{2}$ inch (12 mm.), breadth about $\frac{1}{12}$ inch (2 mm.). Among algæ.

Having seen no specimens of this species, I cannot say whether it is in reality distinct from the foregoing.

IDOTEA WHYMPERI, sp. n.? (Plate I. figs. 6 & 7.)

Idotea, sp.?, *Miers, Journ. Linn. Soc.* xv. p. 64 (1880).

The body is of narrow-oblong form, the head comparatively large, with a very slightly prominent broad and rounded median lobe. The sides of the body are parallel, the segments being of equal width, the three or four posterior having their postero-lateral angles (formed apparently by the laterally projecting epimera) acute. There are four distinct postabdominal segments; the first three very short; the last is triangular in form, with the angles rounded, broadest at base, where it considerably exceeds in width the preceding segments, and with the sides convergent to the distal extremity, which is broad and obtusely rounded. The eyes (black) are placed in the middle of the lateral margins of the head. The antennules are apparently four-jointed; the antennæ have six joints exposed, the four first thickened, and the last two slenderer and more elongated; the last ends in a pencil of fine hairs. The legs are imperfect, but are armed with a sub-terminal as well as a terminal claw. The plates of the operculum are not oblong, but rather oval in shape, narrowing to the distal end. Length scarcely $1\frac{1}{2}$ line (3 mm.).

North mid-Atlantic Ocean, lat. 57° 59′ N., long. 19° 1′ W. The single example was obtained by washing seaweed taken on the surface, and is mounted for the microscope.

The joints both of the antennæ and postabdomen and the epimeral sutures are with difficulty discernible, and perhaps the examination of a larger series of examples would necessitate an emendation of some points in the description; nevertheless, as this example appears to be very distinct from any species with which I am acquainted, I designate it by the name proposed for it at the time of its original description.

IDOTEA DANAI, sp. n. ?

Idotea brevicauda, yg., *Dana, U.S. Expl. Exp.* xiv. (*Cr.* ii.) p. 703, pl. xlvi. fig. 5 (1853).

In this form the body is broadest anteriorly. Head transverse, subtruncate in front, and not embraced by the following segment, with the centre slightly projecting and the sides rounded. The thoracic segments increase in length from the first to the last, the anterior very short, or only partly visible, the three posterior sublunate in an upper view, the posterior margins being concave and the angles prolonged, but obtuse or nearly so. Postabdomen 5-jointed, the first four joints transverse and subequal, the first abruptly narrower than the following or preceding thoracic segment, the fifth oblong, shield-shaped, the sides curving and meeting behind in an angle. Eyes rather large. Antennules less than half the length of the antennæ, the third joint smaller than the second. Antennæ only 7-jointed; the first five joints correspond to the peduncle, the first three are quite short, the second has the outer apex prolonged the length of the third joint, the fourth and fifth are a little oblong, but shorter than the sixth and seventh, the last is acute; a few short hairs on the joints. Legs subequal, increasing from the first pair to the last; the claw is nearly straight, and has a largish subconical base. The posterior plates of the operculum are triangulate, with the distal angle acute (see Dana's figure). Colour brownish grey. Length 1 line.

Loc. Rio Janeiro (harbour).

It appears to be very closely allied to the foregoing, and too distinct from *I. marina* (with which I consider *I. brevicauda* to be synonymous) to be regarded as the young of that species. It is distinguished from *I. Whymperi* by the form of the terminal postabdominal segment, which is no broader than the preceding at its base, and by the more acute terminal plate of the opercular valves. In the outline figure no epimeral sutures are visible.

II. *Postabdomen composed of three distinct segments* (*visible in a dorsal view*) *; and with one or more sutures on the side, indicative of partially coalescent segments.* (Armida, *Risso* ?)

This section includes *Idotea marina* (Linn.), which may be considered the type of the genus in its restricted sense.

a. *Terminal segment dentated or subtruncated or rounded at its distal end.*

As the form of the epimera is not known in all of the species of this subsection, I have not been able to make use of this character in the following analysis of the species to as large an extent as its importance deserves.

* *Terminal segment distinctly toothed or acute at its distal end.*

Oblong-ovate: terminal segment tricuspidate, or more or less acute at its distal end. 1. *I. marina* (Linn.).

Oblong-ovate: terminal segment with a blunt median tooth at its distal end. 2. *I. Whitei*, Stimpson.

Oblong, with subparallel sides: terminal segment more or less triangulate. 3. *I. ochotensis*, Brandt.

Slender-linear: terminal segment with the prominent postero-lateral angles separated by a tooth from the blunt median portion. 4. *I. urotoma*, Stimpson.

** *Terminal segment subtruncated at its distal end.*

α. *Body oblong-ovate.*

Front entire: epimera with the postero-lateral angles more or less projecting; terminal segment not carinated. 5. *I. metallica*, Bosc.

Front apiculate in the middle: terminal segment not carinated. 6. *I. margaritacea*, Dana.

Terminal segment carinated above; joints of the peduncle of the antennæ elongated. 7. *I. pustulata*, Risso.

β. *Body slender, filiform.*

8. *I.* ? *gracillima*, Dana.

*** *Terminal segment regularly rounded at its distal end.*

With a small median point: epimera of second and third segments not quite reaching to postero-lateral angles of these segments. 9. *I. Wosnesenskii*, Brandt.

Entire: epimera reaching quite to postero-lateral angles. 10. *I. lacustris*, Thomson ?

IDOTEA MARINA.

Oniscus marinus, *Linn. Fauna Suecica*, p. 500 (1761); *Syst. Nat.* (ed. xii.) p. 1060 (1766); *Pennant, Brit. Zool.* iv. p. 38, pl. xviii. fig. 3 (1777); *Fabr. Mantissa Ins.* i. p. 241 (1787).

Oniscus tridens, *Scopoli, Entom. Carniolica*, p. 415 (1763); *Olivier, Encycl. Méth.* vi. p. 26 (1791).

Idotea entomon, *Pennant, Brit. Zool.* iv. p. 38, pl. xviii. fig. 5 (1777); *Leach, Edinb. Encycl.* vii. p. 404, pl. ccxxi. fig. 7; *Trans. Linn. Soc.* xi. p. 364 (1815); *nec* Oniscus entomon, *Linn.*

Oniscus balthicus, *Pallas, Spic. Zool.* (9) p. 67, pl. iv. fig. 6 (1772); *Dalyell, Powers of Creator, Crust.* i. p. 228, pl. lxiii. figs. 5–9 (1851).

Asellus marinus (pt.), *Olivier, Encycl. Méth.* iv. p. 254 (1789).

? Cymothoa marina, *Fabr. Ent. Syst.* ii. p. 506 (1793).

? Cymothoa acuminata, *Fabr. t. c.* p. 508 (1793).

? Idotea marina, *Fabr. Ent. Syst. Suppl.* p. 303 (1798); *nec Latr. Hist. Nat. Cr. & Ins.* p. 367, pl. lviii. fig. 5 (1803); *nec Lam. Hist. des Anim. sans Vert.* v. p. 160 (1818).

? Idotea acuminata, *Fabr. Ent. Syst. Suppl.* p. 303 (1798); *Latr. Hist. Nat. Crust. & Ins.* vi. p. 369 (1803); *Eichwald, Fauna Caspio-Caucasia*, p. 185, pl. xxxvii. fig. 6 (1841).

Idotea pelagica, *Leach, Trans. Linn. Soc.* xi. p. 365 (1815); *Desm. Consid. Crust.* p. 289 (1825); *Latr. Cours d'Ent. Atlas*, p. 12, pl. xviii. figs. 20, 30 (1831); *M.-Edw. Hist. Nat. Cr.* iii. p. 129 (1840); *White, List Crust. Brit. Mus.* p. 94 (1847); *Cat. Brit. Crust. Brit. Mus.* p. 65 (1850); *Pop. Hist. Brit. Crust.* p. 223 (1857); *Kinahan, Nat. Hist. Rev., Pr. of Soc.* vi. p. 84 (1859); *M. Sars, Forh. Vidensk.-Selsk. Christ.* p. 151 (1859); *S. Bate & Westwood, Brit. Sessile-eyed Crust.* ii. p. 384, fig. (1868); *Parfitt, Rep. Devon Assoc.* vi. p. 254 (1873); *Metzger, Jahresb. der Commiss. z. Untersuch. des deutschen Meeres in Kiel, Cr.* p. 285 (1875); *Sim, Cat. Cr. Aberdeen*, p. 11.

Stenosoma irrorata, *Say, Journ. Acad. Nat. Sci. Philad.* i. p. 423 (1818); *Hitchcock, Catalogue &c. Massachusetts*, p. 29 (1833); *Gould, Rep. Invert. Massachusetts*, p. 338 (1841); *DeKay, Zool. New York Fauna, Cr.* vi. p. 43, pl. x. fig. 42 (1844).

Idotea tricuspidata, *Desm. Dict. des Sci. Nat.* xxviii. p. 373, pl. xlvi. fig. 11 (1823); *Consid. Crust.* p. 289, pl. xlvi. fig. 11 (1825); *Roux, Cr. de la Méditerranée*, pl. xxxix. figs. 11, 12 (1830); *Gould, Rep. Geol. Mass.* (2 ed.) p. 549 (1835); *M.-Edw. Hist. Nat. Crust.* iii. p. 129 (1840); *Œrsted, Nat. Tidsskr.* iii. p. 561 (1841); *Zaddach, "Synopseos Crust. Prussic. Prodr.* p. 10 (1844)"; *White, List Cr. Brit. Mus.* p. 94 (1847); *id. Cat. Brit. Crust. B. M.* p. 65 (1850); *Pop. Hist. Brit. Crust.* p. 223, pl. xii. fig. 2 (1857); *Lucas, Anim. artic. in Expl. Sci. Algér., Cr.* i. p. 60 (1849); *Hope, Cat. Cr. Ital.* p. 26 (1851); *Burgersdijk, Annotat. de Crust. indigenis*, p. 21 (1852); *Lilljeb. Œfvers. Vet.-Ak. Förh.* (9) p. 11 (1852); *Lindström, ibid.* p. 66 (1856); *M. Sars, Forh. Vidensk.-Selsk. Christ.* p. 151 (1859); *Kinahan, Nat. Hist. Rev., Pr. of Soc.* vi. p. 84 (1859); *Norman, Nat. Hist. Trans. Northumb.* i. p. 25 (1867); *id. Rep. Brit. Assoc.* p. 197 (1868), p. 289 (1869); *Heller, Verh. zool.-bot. Gesellsch. Wien*, xvi. p. 728 (1866); *Marcusen, Arch. f. Nat.* xxxiii. p. 360 (1867); *S. Bate &*

Westwood, Brit. Sessile-eyed Crust. ii. p. 379, fig. (1868); *Czerniavsky, Materialia ad zoograph. ponticam comparatam*, pp. 83, 129 (1868); *Sænger, Fauna of Baltic in "Imp. Soc. Nat. Sci. Moscow*, viii. (1869);" *Münter & Buchholz, Carcin. Fauna Deutschl. in "Mitth. d. nat. Vereins v. Neu-Pommern u. Rügen*, i. (1869);" *Brady & Robertson, Ann. & Mag. Nat. Hist.* (ser. 4) iii. p. 361 (1869); *Cajander, Notiser Fauna & Flora Fennica, Cr.* p. 374 (1869); *Metzger, Naturh. Gesellsch. zu Hannover*, xx. p. 32 (1871); *id. Jahresb. der Commiss. zur wissensch. Untersuch. des deutschen Meeres in Kiel, Cr.* p. 285 (1875); *Möbius, Die wirbellosen Thiere der Ostsee*, p. 121 (1873); *id. Ann. & Mag. Nat. Hist.* (ser. 4) xii. p. 85 (1873); *Parfitt, Trans. Devon Assoc.* p. 254 (1873); *Stebbing, Journ. Linn. Soc. Zool.* xii. p. 148 (1874); *Bos, Bijd. Ken. Cr. Hedrioph. Nederl.* pp. 34, 67 (1874); *McIntosh, Ann. & Mag. Nat. Hist.* (ser. 4) xiv. p. 273 (1874); *id. Marine Invert. St. Andrews*, p. 151 (1875); *Stalio, Att. Istit. Venet.* (ser. 5) iii. p. 1352 (1876–77); *Hoek, Tijd. Ned. Dierk. Vereenig.* p. 41 (1876); *Lenz, Wirbell. Thiere der Travemunde Bucht*, p. 15 (1878); *Sim, Cat. Cr. Aberdeen*, p. 11; *Leslie & Herdmann, Invert. Fauna Firth of Forth*, p. 46 (1881).

Idotea Basteri, *Audouin, Explic. Planches in Savigny's Egypte*, pl. xii. fig. 6; *Guérin, Exp. de Morée*, iii. *Zool. Cr.* p. 49 (1832); *id. Icon. Cr. R. A.* p. 32, pl. xxxi. fig. 1; *Roux, Cr. de la Méditerranée*, pl. xxix. figs. 1–10 (1830); *Rathke, Beitr. zur Fauna der Krym, in Mém. Ac. Pétersb.* iii. p. 380 (1837); *Hope, Cat. Crust. Ital.* p. 26 (1851).

Idotea variegata, *Roux, Crust. de la Médit.* pl. xxx. figs. 1–9 (1830); *Guérin, Exp. de la Morée*, iii. *Zool. Cr.* p. 49 (1832); *White, List Cr. Brit. Mus.* p. 94 (1847).

Idotea (Stenosoma) pusilla, *Eichwald, "Reise auf dem caspisch. Meere*, i. p. 138."

? Idotea brevicornis, *M.-Edwards, Hist. Nat. Crust.* iii. p. 130 (1840).

Idotea irrorata, *M.-Edw. Hist. Nat. Cr.* iii. p. 132 (1840); *White, List Cr. Brit. Mus.* p. 94 (1847); *Stimpson, Marine Inv. G. Manan*, p. 39 (1853); *Leidy, Journ. Ac. Nat. Sci. Phil.* iii. p. 150 (1855); *Harger, Rep. U.S. Fish Com.* pt. i. p. 569, pl. v. fig. 23 (1874); *id. Pr. U.S. Nat. Mus.* ii. p. 160 (1879), vi. *Isopoda*, p. 343, pl. v. figs. 24–26 (1880); *Verrill, Am. Journ. of Sci. & Arts*, vii. pp. 131, 135 (1874); *id. Pr. Amer. Assoc.* pp. 369, 371, 373 (1874); *id. Rep. U.S. Fish Com.* pt. i. p. 316 (1874); *Whiteaves, Am. Journ. of Sci. & Arts* (ser. 3) vii. p. 217 (1874); *id. Further Dredging G. St. Lawrence*, p. 15 (1874).

? Idotea tricuspis, *DeKay, Zool. New York Fauna, Cr.* p. 42, pl. ix. fig. 35 (1844).

? Idotea brevicauda, *Dana, Am. Journ. of Sc. & Arts* (ser. 2) viii. p. 426 (1849); *id. U.S. Expl. Exp.* xiv. (*Cr.* ii.) p. 702, pl. xlvi. fig. 4 (1853).

? Idotea Slabberii, *Bos, Bijd. Cr. Hedrioph. Nederl.* pp. 35, 69, pl. i. figs. 12, 13 (1874).

Idotea baltica, *Meinert, Nat. Tidsskr.* xi. p. 81 (1877).

Body smooth, moderately convex, and not tuberculated or rugose. Head with the antero-lateral angles very little prominent and rounded, the anterior margin very slightly emarginate. First thoracic segment with the antero-lateral lobes subacute and not quite reaching to the eyes. Postabdomen about equalling in length the five preceding thoracic segments; terminal segment with the sides straight and slightly convergent to the distal extremity, which is usually more or less tridentate, with the postero-lateral lobes (or lateral teeth) rounded and much less prominent than the median tooth, which is obtuse; there are usually more or less marked indications of a median keel on the dorsal surface of the segment. In other, even adult, examples there are no indications of any except the median tooth. Eyes small. Antennules with the basal joint little dilated, not reaching beyond the penultimate joint of the peduncle of the antennæ in the adult. Antennæ, when retracted, about reaching to the posterior margin of the fourth thoracic segment, with the last peduncular joint a little longer than the preceding; flagellum with not more than 20 joints, and usually about 16 in the adult. Legs slender; epimera of second to fourth segments more or less oblong and reaching to the posterior margin of the segment, those of sixth and seventh segments with the postero-lateral angles acute. Posterior plates of the operculum suboblong, longer than broad in the adult. Colour very variable. Length of an adult male does not usually exceed $1\frac{1}{6}$ inch (30 millim.), breadth rather more than $\frac{1}{3}$ inch (9 millim.).

The variability of *I. marina* in regard to its colour, markings, and the length and number of articulations in the antennæ, which are generally shorter in the young individual, has been commented on by Messrs. S. Bate and Westwood, Parfitt, and other authors. The younger examples, in their more convex and narrower body, shorter antennæ, and obsolete postero-lateral teeth of the terminal segment, are generally of the form designated by Leach *I. pelagica*. The largest example in the Museum collection (a male from the Shetlands) is nearly $1\frac{5}{12}$ inch in length; in it the antennules do not reach to the end of the antepenultimate joint of the antennæ, and the median posterior tooth of the terminal segment is prominent and elongated. In most of the Mediterranean examples I have seen the median posterior tooth of the terminal postabdominal segment is very short, in some almost obsolete. These may be designated var. *Basteri*, Audouin. It may be convenient to retain

the name var. *pelagica*, Leach, for that variety or condition of this species in which the postero-lateral teeth are absent and the postero-lateral angles rounded off to the terminal tooth or cusp.

The range of this species, as far as ascertained, extends throughout the Mediterranean and Black and Caspian Seas, along the western coasts of Europe northward to Great Britain (Shetlands); it occurs also on the shores of the Netherlands, in the German Ocean and Baltic, on the Scandinavian and Finlandic coasts, on the eastern coast of North America, from Nova Scotia and the Gulf of St. Lawrence southward, at least as far as Egg Harbour (Harger). It occurs on the South-American coast at Desterro and Rio Janeiro in Brazil. Its range on that coast in a southerly direction is as yet unascertained; but the occurrence of specimens, which to all appearance are not specifically distinct, on the New-Zealand coasts points to the probability of its passing southward until it reaches the Antarctic or Southern circumpolar area of distribution. Scarcely explicable by our present theories of the distribution of the recent Crustacea is the fact of its occurrence in the Red Sea, and possibly at Java.

It may be that a more attentive examination of a larger series than I have had at my disposal would reveal the existence of several distinct geographical subspecies or races; but it is certain that even if this be so, they must pass into one another by almost imperceptible gradations, and I have thought it better (on the principle of admitting, as far as possible, none but well-defined species into the present revision) to unite all at present under one specific designation.

The British-Museum collection includes a large number of specimens from various parts of the British coasts, England and Scotland (Colonel Montagu and Dr. Leach), Northumberland (purchased), Weymouth, a young example (Dr. Gray), Cornwall (D. W. Mitchell and W. P. Cocks), Cardiff (R. Drane), and Dalkey Sound, Ireland (Dr. Kinahan), Bell Rock (Dr. Leach, types of *I. pelagica*), and Beerhaven (Sir P. Egerton). All of the above are preserved dry. Two fine males from the Shetland Islands (R. MacAndrew), one from Anstis's Cove, Torquay (Rev. T. R. R. Stebbing), and two from Vineyard Sound, Massachusetts, presented by the Smithsonian Institution (as *I. irrorata*), and collected by the U.S. Fish Commission, are preserved in spirits.

There are also dried specimens from Genoa and Sicily (Old Collection), three of unknown locality collected during the voyage of H.M.S. 'Herald,' and two from Egg Harbour, United States (T. Say), designated *I. irrorata*; one also from Pictou, Nova Scotia, to which White applied the name of *I. oxyura*.

In the fine series preserved in spirit in the Paris collection are the type specimens of the *Idotea tricuspidata* of Desmarest, from La Rochelle, and of Milne-Edwards, from Oran. The former well represents what may be considered the typical condition of the species, in which the median lobe of the distal end of the terminal segment is considerably more prominent than the lateral ones, which yet are distinct, and the body is of somewhat oblong-oval shape.

In this collection there are specimens from Iceland (Cape Research), Bohuslan (Malm), Dublin (Kinahan), the Channel, Bona on the Algerian Coast (M. Lucas and M. Letourneux). From the latter locality a large series of specimens show great variation in the purplish markings of the body, but very little in the form of the terminal segment, in which the median tooth of the posterior margin is very short; the same is true of the very numerous series from the Channel.

I have also had under my examination the types (all more or less imperfect) of *Idotea brevicornis*, M.-Edwards, from Australia ("Baie des chiens marins," M. Freycinet), and cannot regard them as specifically distinct from *I. marina*. The differences mentioned by Milne-Edwards in his description cannot be considered of specific importance, in view of the great degree of variability now ascertained to exist in European specimens of this species.

A male from the Red Sea (M. Clot-Bey) is of large size, with largely-developed posterior epimera, and terminal segment with a prominent median tooth. Another from Java (Exp. de la 'Chevrette') is in fragmentary condition, but probably belongs to this species. Three specimens (male and two females) are in the collection from Brazil, Desterro (Dr. F. Müller), which closely resemble, except for their pale colour, specimens from the Mediterranean and British Channel, and a male from New Zealand (M. Petit); also a female from the Atlantic Ocean (M. A. Edwards) designated *I. brevicauda*.

In the Linnean Cabinet at the rooms of the Linnean Society in Burlington House is a specimen which bears the name "*mari-*

nus," in what is undoubtedly Linnæus's handwriting*. Hence I have little hesitation in citing his name for this species. Latreille and Lamarck apparently confounded two distinct species under the name *I. marina*.

The *Idotea brevicauda*, Dana, from Rio de Janeiro, I believe to be synonymous with *I. marina*, although, in the remarks following the specific description, the author says, "Like the front, the centre of the caudal margin is apiculate." According to the specific description, however, and the figure, the front is truncated, without any median prominence.

The small example figured by Dana (pl. xlvi. fig. 5) as possibly the young of this species is designated above *I. Danai*.

The species designated *I. tricuspidata* by Catta, Ann. Sci. Nat. (ser. 6) iii. p. 31 (1876), appears, from the description of the terminal segment, not to be referable to *I. marina*. It may perhaps be *I. metallica*, Bosc.

Idotea Slabberii, Bos (*t. c.*), is, according to its author, only distinguished by its more oblong form and relatively shorter antennæ; the figure, which is a mere outline sketch, is obviously inaccurate as regards the segmentation of the postabdomen and the form of the epimera. It appears to represent var. *pelagica*.

IDOTEA MARINA, var. PHOSPHOREA.

Idotea oxyura, *White* (*ined.*).

Idotea phosphorea, *Harger, Rep. U.S. Fish Commission*, i. p. 569 (1874), vi. p. 347, pl. v. figs. 27–29 (1880); *id. Proc. U.S. Nat. Mus.* ii. p. 160 (1879); *Verrill, Am. Journ. Sci. & Arts*, (ser. 3) vii. pp. 43, 45, 131 (1874); *id. Rep. U.S. Fish Commiss.* i. p. 316 (1874); *Whiteaves, Am. Journ. Sci. & Arts*, (ser. 3) vii. p. 218 (1874); *id. Further Dredging G. St. Lawrence*, p. 15 "(1874)."

This variety (or possible species) is nearly allied to *I. marina*, but may be distinguished by its rougher and more tuberculate body, and generally by its more acute terminal postabdominal segment, which, in the specimens I have seen (and in Harger's figure), is rounded off at the distal end to the median terminal tooth, which is somewhat produced. The epimeral sutures of the second and third thoracic segments do not completely cross the segment, but allow the rounded postero-lateral lobes of these segments to form a part of the lateral margin. Length about 1 inch (25 mm., Harger), breadth rather more than $\frac{1}{4}$ inch (7 mm.).

* The label has been pronounced to be in the handwriting of Linnæus by Dr. Ewald Åhrling of Arboga, Sweden, a gentleman well versed in all matters concerning the MSS. and correspondence of Linnæus.

As we learn from Mr. Harger's Report, it is found associated with the last among rocks and weed along the entire coast of New England, and extends northward to Halifax, Nova Scotia, and the Gulf of St. Lawrence. It appears to have a more northern range on that coast than *I. marina*. The colour is very varied, but never of the striped pattern so common in *I. marina*.

To this from belong two out of three specimens from Pictou, Nova Scotia (Lieut. Redman), in the collection of the British Museum, to which White applied the MS. name of *I. oxyura*. The third specimen I refer to *I. marina*. Nearly allied as the two forms undoubtedly are, the character of the epimera, with the other distinctions mentioned, apparently suffice to distinguish them, at least as varieties.

There appears to be no sufficient reason to distinguish *Idotea granulosa* of Rathke (Beitr. Fauna Norwegens, in Nov. Act. Nat. Curiosorum, xx. p. 23, 1843), from Christiansund and Drontheim, from the American *I. phosphorea*. Rathke's specimens scarcely differ (according to his description), except in their shorter antennæ and colour, characters of little value. His specimens were of small size (6 lines), but have a granular carapace, and the form of the terminal postabdominal segment is similar. As, however, the form of the epimera is not mentioned, I retain for the present Harger's name for the specimen from Nova Scotia in the Museum collection.

IDOTEA OCHOTENSIS. (Plate I. figs. 8–10.)

Idotea ochotensis, *Brandt, in Middendorff's Sibirische Reise,* ii. *Cr.* p. 145, pl. vi. fig. 33 (1851).

In this species the body is elongated, raised like a keel in the middle of the line, sloping, smooth, and naked on the sides. The anterior frontal margin is deeply emarginate and compressed posteriorly; antero-lateral lobes very conspicuous, arcuated, bent downward and forward, so as wholly to cover the basal antennal joint. All the thoracic segments broad on the sides, very straight-edged, with their posterior and inferior angles more or less right angles. Postabdomen composed of three distinct segments, the terminal segment much elongated, quadrangulate, with straight lateral margins; posterior margin with a triangulate tooth-like process, which gives out a keel that extends along the whole length of the dorsal surface of the segment in the median line. Eyes small. Antennules short, not reaching to the end of the

third joint of the peduncle of the antennæ. Antennæ, when retracted, reaching to about the posterior margin of the fourth thoracic segment; flagellum about 15-jointed and shorter than the peduncle. Epimera of the second to fourth thoracic segments occupying scarcely more than the anterior half of their lateral margins, of the fifth and sixth segments about three quarters, and of the seventh segment the whole of the lateral margins. Colour very variable: back reddish brown or olive-green, often with yellow clouded or dot-like markings, or even with a yellowish stripe on the back.

This species was obtained by Middendorff in the Sea of Ochotsk, and by Wosnesensky in Awatscha Bay. Its range, as far as ascertained, extends along the eastern coast of Asia northward from the Sea of Japan, and along the west coast of N. America southward to British Columbia and Vancouver Island.

A fine male in the British-Museum collection, length nearly $1\frac{3}{4}$ inch (43 mm.), preserved in spirits, and collected by Capt. St. John off the N.E. of Yedo Island (J. Gwyn Jeffreys), differs from Brandt's figure of *I. ochotensis* only in its relatively longer and slenderer body and somewhat shorter antennæ, which, when retracted, would not reach to the posterior margin of the fourth thoracic segment, but whose peduncular joints are longer than in Brandt's figure; the flagellum is 13-jointed.

On the other hand, a male of smaller size, in spirit, from British Columbia (J. K. Lord), length about $1\frac{1}{12}$ inch (28 mm.), much more nearly resembles Brandt's figures in these particulars; but the keel-like elevation of the median dorsal line of the thorax is obsolete; the flagellum of the antennæ is 18-jointed.

In a small example (in spirit), length nearly $\frac{3}{4}$ inch (18 mm.), obtained at Vancouver Island (Boundary Commission), the antennæ are yet longer, reaching beyond the posterior margin of the fifth thoracic segment, the flagellum longer than the peduncle and 19-jointed, the dorsal keel of the thorax and terminal segment is obsolete, and the tooth at its distal extremity, which is very prominent in the large male from Japan, but less so in the specimen next referred to, is in this quite obscurely defined. Having regard to the marked variations which exist between the adult and young of some other species (e.g. *I. marina*), I will refer all three specimens, provisionally at least, to *I. ochotensis* rather than incur the possibility of further complicating the synonymical references in this genus by unnecessary specific names.

In Brandt's figure and in the British-Columbian examples the postabdomen about equals the last four thoracic segments in length. In the Japanese example the postabdomen about equals $3\frac{1}{2}$ segments.

In the collection of the Paris Museum is a male (Mus. St. Petersburg) that agrees very nearly with the above description, but the keel on the terminal segment is partially obsolete, antennæ 14–15-jointed; in two males from the Amur (M. A. Edwards) the keel is obsolete and the flagellum (only one perfect) 11-jointed. A fine male without locality (Exped. de la Vénus, M. Néboux) has no trace of a dorsal keel, and has a 12-jointed antennal flagellum.

The *Idotea rectilinea* of Lockington (Proc. Cal. Acad. Sci. vii. pt. i. p. 36, 1877) is described as having the body slender, all the thoracic segments equal in length and width. Postabdomen rectilinear, nearly as wide as the thorax, with the first two segments distinct; its total length about equal to that of the last three thoracic segments; its posterior extremity obtusely pointed. Antennæ long; peduncle equal in length to the three first segments of the body; flagellum broken in both specimens. Colour variable: one dried specimen almost entirely black, the other with a black line down centre of body, the rest of which is yellowish. Length 0·80 inch, width 0·17 inch.

Loc. San Diego.

Nothing is stated concerning the epimera; but, as far as the description goes, this species is scarcely to be distinguished from the foregoing.

IDOTEA UROTOMA.

Idotea urotoma, *Stimpson, Pr. Ac. Nat. Sci. Phil.* p. 155 (1864).

According to Stimpson, this has the body nearly linear, nearly five times as long as broad, broadest at the sixth thoracic segment. Postabdomen consisting of three joints, with the partial separation of a fourth, subrectangular, with convex extremities, and scarcely less broad at its truncate posterior extremity than at the anterior. The posterior extremity is peculiar in shape, the angle on either side projecting strongly, and separated by a tooth from the convex or subtriangular middle portion, which bears a small tooth at the middle. Antennæ a little more than half as long as the body; last two joints of the peduncle subequal; flagellum a little shorter than the peduncle and 10-jointed. Thoracic legs

slender. Opercular valves large, nearly covering the entire underside of the postabdomen. Length of body 0·75 inch, greatest breadth 0·17; length of postabdomen 0·20 inch.

Hab. Puget Sound (Stimpson).

I have seen no specimens having the peculiar form of the terminal postabdominal segment as described above. In other particulars this species appears to be allied to *I. ochotensis*.

IDOTEA? GRACILLIMA.

Stenosoma gracillimum, *Dana, Pr. Acad. Nat. Sci. Philad.* vii. p. 175 (1854); *Stimpson, Bost. Journ. Nat. Hist.* vi. p. 505 (1857).

Has, according to Prof. Dana, an extremely slender filiform body, with the thoracic segments for the most part subquadrate; head quadrate. Postabdomen linear, truncated at apex, 3-jointed, third segment marked on each side with a suture. Antennæ a little shorter than half the body, with the flagellum 10–12-jointed, shorter than the peduncle, naked. Legs very short, subequal. Length 5½ lines.

Loc. California (Dr. J. LeConte).

This species is very briefly described; but I have seen no specimens which can be referred to it.

IDOTEA METALLICA.

Idotea metallica, *Bosc, Hist. Nat. Crust.* ii. p. 179, pl. xv. fig. 6 (1802); *Latr. Hist. Nat. Cr. et Ins.* vi. p. 373 (1803).

? Idotea atrata, *Costa, Fauna del R. Napoli, Cr.* pl. xi. fig. 3 (1838); *Hope, Cat. Cr. Ital.* p. 26 (1851).

Idotea rugosa, *M.-Edw. Hist. Nat. Crust.* iii. p. 131 (1840).

? Idotea peloponesiaca, *Roux, Cr. de la Méditerranée,* pl. xxx. figs. 10, 12 (1830); *Hope, Cat. Cr. Ital.* p. 26 (1851).

Idotea robusta, *Kröyer, Naturhist. Tidsskr.* (ser. 2) ii. p. 108 (1846); *id. Voy. en Scand., Crust.* pl. xxvi. fig. 3; *Reinhardt, Forteg. over Grönlands Krebsdyr,* p. 35 (1857); *Stimpson, Pr. Ac. Nat. Sci. Phil.* p. 133 (1863); *Verrill, Am. Journ. Sci. & Arts,* ii. p. 360 (1871); *id. Rep. U.S. Fish Commiss.* i. p. 439 (1874); *Harger, same Report,* i. p. 569, pl. v. fig. 24 (1874); *Proc. U.S. Nat. Mus.* ii. p. 160 (1879); *Rep. U.S. Fish Commiss.* vi. p. 349, pl. vi. figs. 30–32 (1880); *Lütken, List of Crust. of Greenland, in Arctic Manual,* p. 150, footnote (1875).

Idotea compacta, *White, List Crust. Brit. Mus.* p. 95 (1847).

? Idotea algirica, *Lucas, Anim. artic. in Expl. Sci. Algérie,* i. *Cr.* p. 61, pl. vi. fig. 2 (1849); *Heller, Verh. zool.-bot. Gesellsch. Wien,* xvi. pp. 727, 728 (1866); *Stalio, Att. Istit. Venet.* (ser. 5) iii. p. 1353 (1876–77).

Idotea argentea, *Dana, Amer. Journ. of Sci. & Arts,* (ser. 2) viii. p. 426 (1849); *id. U.S. Explor. Exped., Crust.* xiv. p. 698, pl. xlvi. fig. 1 (1853); *Miers, Cat. New-Zealand Crust.* p. 92 (1868).

Idotea annulata, *Dana, Amer. Journ. of Sci. & Arts,* (ser. 2) viii. p. 426 (1849); *id. U.S. Explor. Exped.* xiv. *Crust.* p. 701, pl. xlvi. fig. 3 (1853); *Cunningham, Trans. Linn. Soc.* xxvii. p. 499 (1871); *nec Miers, Proc. Zool. Soc.* p. 76 (1881).

This species is oblong-oval, moderately convex, the somewhat projecting epimera usually giving, in the adult, a serrated appearance to the sides of the thorax. The head is transverse, with the anterior margin slightly concave; the antero-lateral angles rounded and but little prominent; near the posterior margin of the head is a deeply impressed arcuated transverse furrow. The surface of the body is more or less rugose; the lateral sutures on the dorsal surface of the postabdomen posterior to the second segment are strongly marked, nearly straight, and directed obliquely upward toward the middle line of the body; the terminal segment is convex, nearly oblong, rounded at the postero-lateral angles; posterior margin square-truncated, or very slightly excavated, or with a very obscure median denticle. The eyes are large and prominent. The terminal joint of the peduncle of the antennæ longer than the preceding; the flagellum short, usually 7–10-jointed. The epimera are well developed, with the postero-lateral angles subacute and usually somewhat projecting in the adult; the basal plate of the opercular valves is oblong, with parallel sides; the terminal plate nearly square, but rounded off at its externo-distal angle. The length of an adult male may exceed 1 inch (28 millim., Harger); but the majority of the specimens in the Museum collection do not exceed ⅔ inch (17 millim.).

The colour, according to Harger, is bright blue or green when alive, becoming darker and duller in alcohol, without the markings of the other species, but often with metallic reflections. In by far the greater number of specimens that I have seen, whether preserved dry or in spirit, the lateral margins of the epimera are paler, and there is a more or less distinct transverse band of pale colour on the posterior margin of the terminal segment.

The robust antennæ, large eyes, rugose thoracic segments, and square-truncated terminal postabdominal segment will always distinguish this species from varieties of *Idotea marina* with the lobes of the terminal segment obsolete.

This is apparently a very common and almost cosmopolitan

pelagic species, occurring probably everywhere, except in Arctic and Antarctic latitudes. Specimens from the open sea, but without indication of locality, are in the Museum collection, obtained during the voyages of H.M.SS. 'Herald' and 'Rattlesnake,' &c.; three males and two females in spirit from the N. Atlantic, lat. 55° 49′ N., long. 16° 44′ W. ('Valorous' Exped., as *I. robusta*); from the N. Atlantic, lat. 20° N., long. 22° 53′ W., an adult male and four smaller specimens, and lat. 31° 30′ N., long. 23° 0′ W., an adult male, female with ova, and young, both obtained from the towing-net and preserved in spirit; a young example, in spirit, from the Mediterranean; an adult male and two females, in spirit, from the Atlantic (Capt. J. B. Godfrey); two males, in spirit, from Vineyard Sound, Massachusetts (U.S. Fish Commiss., as *I. robusta*); a male and two females from W. Africa (Bewsher); a series of specimens from the South Atlantic, lat. 34° 43′ S., long. 4° W., and lat. 35° 21′ S., long. 35° 22′ W., preserved dry, and collected by J. MacGillivray (H.M.S. 'Rattlesnake'); several specimens, in spirit, collected between Monte Video and the Straits of Magellan (Dr. R. O. Cunningham, as *I. annulata*); a series of specimens, in spirit, from the S. Pacific, lat. 25° 18′ S., long. 178° 54′ W. (H.M.S. 'Herald,' as *I. pelagica*); three specimens (preserved dry) from Cape Byron, N. S. Wales (collected by J. MacGillivray, H.M.S. 'Rattlesnake'), and one, dry, from Borneo (Admiralty), designated by White as *I. compacta*; besides others, whose locality has either never been recorded or has been lost.

It is remarkable that no specimen should (so far as I am aware) have as yet been recorded from the British coasts.

I have observed considerable variation in the degree of prominence of the epimera and in the width of the thoracic segments. In some, even adult, examples the epimera do not project at all, and the serrated appearance of the sides of the thorax is lost. The younger individuals are generally narrower, with the sides more nearly parallel.

I think that the *I. peloponesiaca* of Roux is to be referred to this species rather than to *I. emarginata*, where M. Roux and S. Bate and Westwood place it, on account of the prominent eyes, serrated lateral margins of the thorax, and the coloration. The terminal segment is described as convex and truncated, although represented as slightly emarginated. Guérin, Exp. de Morée, Cr. p. 49 (1832), adds no information about this species.

In the large series in the collection of the Paris Museum the following are of interest on account of the locality:—specimens of both sexes from Algiers (M. Lucas), and designated *Idotea algirica*, Lucas; the type specimens of *I. rugosa*, M.-Edw., from the open sea, Indian Ocean, and other specimens from Sumatra (M. Bourdes), designated *I. rugosa*; one of these measures 1⅙ inch (30 mm.) in length: also examples from St. Helena (Dussumier); Teneriffe (Quoy & Gaimard), small and of pale colour; a fine series from the Cape of Good Hope, and four specimens from Port Jackson (M. Freycinet), &c.

In the specimens designated *I. algirica* by Lucas the body is not pubescent, and the lateral serratures caused by the projecting epimera, although strongly marked, are not so prominent as in Lucas's figure. Dr. Heller notes the occurrence of this species, but rarely, at Lesina.

Idotea brevicornis of Rathke, nec Edw., "Beitr. zur Fauna Norwegens," in Nova Acta Acad. Cæs. Nat. Curiosorum, xx. p. 24 (1843), from Christiansund, is described too briefly for me to be certain of its systematic position. The eyes are very large and black; the antennæ have a 7–8-jointed flagellum and are altogether very thick, and reach, at farthest, to the second thoracic segment; the postabdomen is in its posterior portion not so much ridged as very bluntly angulated; it is rounded at the end, with only very feeble indications of a median apical point; moreover the postabdomen is short, compressed, and but little narrowed towards its apex. The legs are short and thick, yet the posterior pair reaches, because of the smallness of the postabdomen, a little beyond it, which is not usual in the genus *Idotea*. Colour olive-green, in some specimens approaching black, in others yellow; no mottlings were noticed. Length of a male not exceeding 7½ lines; female much smaller.

It is not improbably identical with *I. metallica*.

IDOTEA MARGARITACEA.

Idotea margaritacea, *Dana, U.S. Explor. Exped.* xiv. *Crust.* p. 700, pl. xlvi. fig. 2 (1853); *Miers, Cat. New-Zeal. Crust.* p. 92 (1876).

Is apparently very closely allied to the preceding species, and should perhaps not be regarded as distinct from it. Dana, however, describes the front as 3-toothed, the three teeth very low, one occupying either angle, and the third, which is less distinct, the middle of the front; the outer are subacute, and the spaces

between low-concave; the body is not quite as much narrowed behind, and the flagellum of the outer antennæ has but four or five joints. It was obtained between Australia and Southern New Zealand, five hundred miles from Port Jackson, N. S. Wales.

I have never observed any specimens of *I. metallica* with a tridentate front.

IDOTEA PUSTULATA.

Armida pustulata, *Risso, Hist. Nat. Eur. mérid.* v. p. 110 (1826).

This species is apparently allied to *I. metallica* and *I. ochotensis*. It is described as follows:—"Body of a deep bluish grey, with all the segments acute on the sides; head pustulated; eyes black; the first four joints of the antennæ elongated, the fifth longer, the others very short; the four joints of the antennules as long as the two first antennal joints; 'palpi' pectinated; legs somewhat roughened; segments of postabdomen narrow, the last carinated, almost truncated at apex." Length about 1 inch (25 millim.), breadth rather more than $\frac{1}{4}$ inch (7 millim.).

It is apparently distinguished from *I. metallica* by the longer peduncular joints of the antennæ and the carinated terminal segment, wherein it resembles *I. ochotensis*; but whether it be really distinct could only be determined by examination of specimens. It is probably the species referred to by Hope (Cat. Crust. Ital. p. 26, 1851), without description, under the designation *Armida punctulata*, Risso.

? IDOTEA LACUSTRIS. (Plate I. figs. 11 & 12.)

Idotea lacustris, *Thomson, Trans. New-Zeal. Inst.* xi. p. 250 (1879).

Is described by Mr. Thomson as having the body narrow-elliptical, little more than twice as long as broad; front of head excavated, not toothed; first segment of thorax somewhat longer than those succeeding, which are subequal; postabdomen three-jointed, terminal joint (formed of three coalescent segments) hardly narrowing to the rounded extremity; antennules not half as long as the base of the antennæ, 4-jointed, joints subequal; antennæ one third as long as the body; flagellum 9–11-jointed, with a dense fringe of very short setæ on the outer margin; epimera nearly square, the last three slightly produced posteriorly. Colour dark grey mottled with brown, with a duller median band extending from the head to near the extremity of the postabdomen. Length $\frac{3}{8}$ inch.

Numerous specimens were found in the Tomahawk lagoon, near Dunedin (Prof. Hutton). They were creeping about under stones, and appeared to be feeding on the ova of a fish, probably *Galaxis*, which was found abundantly in the same locality. It is chiefly remarkable, as Mr. Thomson points out, for its occurrence in fresh water, though whether it lives there permanently or only comes up when a very high tide renders communication with the lagoon possible, is uncertain.

The freshwater habitat is not peculiar to this species, since Prof. Lovén has detected *Glyptonotus entomon* in the Swedish lakes (Œfvers. Vetensk.-Akad. Förhandl. Stockholm, xviii. p. 286, 1862.)

In numerous females the incubatory pouch extended along the whole undersurface of the thorax. The young animals, taken out of this sac, have their bodies somewhat elongated in shape, with all the segments developed and appendages present, but having the outer antennæ furnished with a flagellum of only one joint, and a few short setæ.

The figure is from specimens in the British-Museum collection from Port Henry, Straits of Magellan (Dr. R. P. Coppinger), that agree fairly well with the above description, but which I refer with much hesitation to *I. lacustris*, on account of the widely-remote locality at which they were obtained and their (probable) marine habitat. I at first (Proc. Zool. Soc. 1881, p. 76) referred them with doubt to *I. annulata*, Dana, a species that in this revision is regarded as synonymous with *I. metallica*. The colour in these specimens is of a uniform chestnut-brown, the front margin of the head very slightly excavated, and the flagella of the antennæ 7-jointed. If distinct, they may be designated *I. rotundicauda*.

IDOTEA WOSNESENSKII.

Idotea Wosnesenskii, *Brandt, in Middendorff's Sibirische Reise, Zool.* ii. *Cr.* p. 146 (1851); *Stimpson, Bost. Journ. Nat. Hist.* vi. p. 504 (1857); *S. Bate, in Lord's Nat. in Brit. Columbia*, ii. p. 281 (1866).

Idotea hirtipes, *Dana, Cr. U.S. Expl. Exp.* xiv. (2) p. 704, pl. xlvi. fig. 6 (1853), *nec M.-Edwards.*

Idotea oregonensis, *Dana, Pr. Acad. Nat. Sci. Phil.* vii. p. 175 (1854).

Idotea media (*Dana?*), *S. Bate, in Lord's Nat. in Brit. Columbia*, ii. p. 282 (1866).

Is characterized by its oblong-oval, convex body, which is relatively shorter and broader than in *I. ochotensis*, and is without

a median dorsal keel. Head nearly smooth, its antero-lateral angles rounded and not prominent, and its anterior margin very slightly sinuated or nearly straight, the impressed line near the posterior margin faintly marked or quite obsolete. The first thoracic segment has its antero-lateral angles anteriorly produced and broadly rounded, the two following segments less distinctly so; all the thoracic segments are of nearly equal length in the median dorsal line. The terminal postabdominal segment is convex, not $1\frac{1}{2}$ times as long as broad, bluntly rounded at its distal end, with a small blunt median terminal tooth, posterior to which is usually indicated a longitudinal median keel, which is prolonged backward for a short distance on the dorsal surface of the segment. Eyes small. Antennules very short, not reaching to the distal end of the antepenultimate joint of the peduncle of the antennæ. The antennæ, when retracted, do not surpass the posterior margin of the third thoracic segment; the last two joints of the peduncle are short, subequal, each scarcely longer than the antepenultimate joint; flagellum 12–14-jointed. Epimera of second to fourth thoracic segment narrow-linear and not reaching quite to the postero-lateral angles of these segments; the epimera of the fifth to seventh thoracic segments become successively broader, and reach to the postero-lateral angles of the segments. The terminal joints of all the legs are usually armed with a small accessory claw; the terminal plates of the operculum are not oblong, but have their exterior margins regularly arcuated. Length of an adult male about $1\frac{1}{4}$ inch (32 millim.), breadth about $\frac{5}{12}$ inch (11 millim.).

This species ranges from the Sea of Ochotsk and Kamtchatka Sea, along the western coast of North America, to the coast of California.

Specimens are in the British-Museum collection, preserved dry, from Vancouver's Island (J. K. Lord, as *I. Wosnesenskii* and *I. media*), and in spirit (of both sexes) from Skedegate Bay, Queen Charlotte Island (purchased of Dr. Brown); also a male from Fort Rupert (Dr. Brown), and three males from San Francisco, California (W. N. Lockington, as *I. Wosnesenskii*).

In the Paris collection is an adult male of large size, with very robust and hairy legs, from Unalaschka, three examples from California (with *I. Whitei*), and two small specimens, without locality, designated *I. oregonensis*; also a good series from the Gulf of Georgia (A. Agassiz).

The *Idotea media*, Dana (Pr. Acad. Nat. Sci. Philad. vii. p. 175, 1857; Stimpson, Boston Journ. Nat. Hist. vi. p. 504, 1857), from California, is briefly characterized by Dana as allied to *I. oregonensis* (=*I. Wosnesenskii*), but is a little narrower. Body smooth, with the sides slightly arcuated; postabdomen $1\frac{1}{2}$ times longer than broad, with the sides nearly parallel, distal end arcuate-truncate and apiculate in the middle. Antennæ not longer than one third the body; flagellum 10–12-jointed, scarcely shorter than the peduncle, nearly naked. Legs nearly naked. Length 10 lines.

The postabdomen is 3-jointed, with an additional suture on each side of the last segment, as in *I. oregonensis*.

The description does not suffice to distinguish this species from *I. Wosnesenskii*; Stimpson merely adds that it is distinguished by its longer postabdomen. As nothing is said respecting the epimera, it may prove to be allied to or identical with the following.

IDOTEA WHITEI. (Plate II. figs. 1–3.)

Idotea Whitei, *Stimpson, Proc. Ac. Nat. Sci. Phil.* p. 155 (1864).

Is, according to Stimpson, allied to *I. Wosnesenskii*, but is very much more elongated, and only differs from *I. media*, Dana, in its longer antennæ. It is described as slender, with the sides slightly convex; head large; antennæ nearly two thirds as long as the body, the flagellum equalling the peduncle in length and 16–18-jointed; first thoracic segment short, less than two thirds as long as the second; postabdomen segmented, as in *I. Wosnesenskii* and other members of the group, half longer than broad, slightly narrowing posteriorly, with the extremity rounded, truncate, and bluntly acuminated at the middle; legs moderately stout. Colour yellowish, minutely punctate with dark grey. Length of body 0·81, length of postabdomen 0·27 inch. The species inhabits Puget Sound.

I refer here, with some hesitation, two males in the collection of the Paris Museum, received from California together with three specimens of *I. Wosnesenskii*. They agree with Stimpson's description in their more elongated body and the 16–18-jointed flagellum of the antennæ, and are further distinguished from *I. Wosnesenskii* by the form of the epimera of the second to fourth thoracic segments, which reach quite to the postero-latera angles of these segments: the epimera of the second segment are broader anteriorly, and the terminal segment more resembles that

of *I. ochotensis*, being more angulated and less rounded at the postero-lateral angles. The colour (of the spirit-specimens) is a purple-pink, with markings of light yellow and darker brownish pink. Length of the largest example rather more than 1 inch (27 millim.).

It is possible that the examination of a larger series would demonstrate the necessity of uniting this species with *I. Wosnesenskii*.

b. *Terminal segment distinctly emarginate at its distal end.*

The species of this subsection may be distinguished as follows:—

* *Epimera broad, those of the second to fourth segments occupying the whole of the lateral margins.*

Oblong-ovate: terminal segment with the postero-lateral angle subacute. 1. *I. emarginata* (Fabr.).

** *Epimera of second to fourth thoracic segments occupying the anterior part of the lateral margin.*

Oblong-ovate: antennæ not as long as the cephalothorax; terminal segment deeply emarginate, with acute postero-lateral angles. 2. *I. resecata*, Stimpson.

Slender: antennæ robust, as long as the body (in the adult); terminal segment sometimes with a small median cusp, postero-lateral angles acute. 3. *I. linearis* (Linn.).

Oblong-ovate: antennæ not as long as the cephalothorax; terminal segment very slightly emarginate, postero-lateral angles subacute. 4. *I. indica*, M.-Edw.

*** *Epimera not distinguishable in a dorsal view.*

Suboblong: body dorsally carinated; terminal segment deeply emarginate, with acute postero-lateral angles.

5. *I. hectica* (Pallas).

IDOTEA EMARGINATA.

? Squilla marina, *De Geer, Mém. Hist. des Ins.* vii. p. 522, pl. xxxii. figs. 11–14 (1778).

Cymothoa emarginata, *Fabr. Ent. Syst.* ii. p. 508 (1793).

Idotea emarginata, *Fabr. Ent. Syst. Suppl.* p. 303 (1798); *Latr. Hist. Nat. Cr. et Ins.* vi. p. 370 (1803); *M.-Edw. Hist. Nat. Cr.* iii. p. 130 (1840); *id. Cr. in Cuvier's Règne Anim.* (*éd.* 3), pl. lxix. fig. 2; *White, List Cr. Brit. Mus.* p. 94 (1847); *id. Cat. Brit. Cr. B.M.* p. 65 (1850); *id. Pop. Hist. Brit. Crust.* p. 224 (1857); *Hope, Cat. Cr. Ital.*

p. 26 (1851); *Kinahan, Nat. Hist. Rev., Pr. of Soc.* vi. p. 84 (1859); *S. Bate & Westw. Brit. Sessile-eyed Cr.* ii. p. 386, fig. (1868); *Brady & Robertson, Ann. & Mag. Nat. Hist.* (ser. 4) iii. p. 361; *Parfitt, Rep. Devon Assoc.* vi. p. 255 (1873); *Metzger, Jahresb. der Commiss. z. wiss. Untersuch. des deutschen Meeres,* p. 285 (1875); *Meinert, Nat. Tidsskr.* (3 R.) xi. p. 82 (1877), xii. p. 470 (1880); *Sim, List Cr. Aberdeen,* p. 11.

? Idotea excisa, *Bosc, Hist. Nat. des Crust.* ii. p. 181 (1802).

? Idotea marina, *Latr. Hist. Nat. Cr.* vi. p. 367, vii. pl. lviii. fig. 5 (1803–4); *Lam. Hist. Anim. sans Vert.* v. p. 160 (1818), *nec Linn.*

Idotea œstrum, *Leach, Linn. Trans.* xi. p. 365 (1815); *Desm. Consid. Cr.* p. 289 (1825).

The body is convex, oblong-oval, nearly smooth. Head with the anterior margin nearly straight, almost imperceptibly concave, its antero-lateral angles not at all prominent; segments of the thorax of nearly equal length in the middle line of the back, the first segment with rounded or subacute antero-lateral lobes that reach to or nearly to the eyes; postabdomen longer than the four posterior thoracic segments, terminal segment convex above, with the lateral margins nearly straight and slightly convergent posteriorly to the distal extremity, which has a rather broad and shallow emargination; the postero-lateral angles of the terminal segment are rounded or subacute, never acute. Eyes small, black. Antennules usually not reaching to the distal end of the penultimate joint of the peduncle of the antennæ, with their basal joints moderately dilated. Antennæ of moderate length, usually not reaching, when retracted, to the posterior margin of the fourth thoracic segment; the terminal joint of the peduncle but little longer than the preceding; the flagellum 12–20-jointed. Epimera large and broadly developed; those of the three or four posterior segments with the postero-lateral angles subacute. Opercular valves with the terminal plates nearly square, their distal ends slightly emarginated. The colour in dried or spirit-specimens is a more or less yellowish brown, the surface of the body being covered with minute dots which are not always visible. The largest specimen I have seen measures nearly $1\frac{5}{12}$ inch (35 millim.) in length, and its greatest breadth is nearly $\frac{1}{2}$ inch (11 millim.); but adult examples are usually smaller.

This species probably occurs, but (it would seem) locally, throughout the warmer and temperate seas of Europe. It has been recorded from the Mediterranean, British, Danish, and Southern Scandinavian coasts, Heligoland, &c.

The British-Museum collection contains specimens from various localities on the British coasts (Col. Montagu and Dr. Leach) and a male from the Mediterranean, all preserved dry; also two males from Bohuslan (Dr. A. W. Malm), preserved in spirit. In the Paris collection also are two specimens from Bohuslan (Malm), and others without locality.

Mr. Norman, in Messrs. Brady and Robertson's Report on dregding in the West of Ireland, in the Ann. & Mag. Nat. Hist. for 1869, above quoted, mentions the occurrence of the young of this species in extraordinary abundance among Algæ between Ardbear and Mannin Bays.

In young individuals the body is relatively narrower, and the terminal notch is often shallower than in the adult.

The colour of the two small specimens obtained by Mr. Parfitt (*t. c.*) was deep chocolate or reddish brown, with a row of white ocelli-like spots along the dorsal ridge and two or three white blotches on the side; posterior edge of the tail edged with white; legs dark, and claws bright vinous red.

IDOTEA RESECATA.

Idotea resecata, *Stimpson, Bost. Journ. Nat. Hist.* vi. p. 64, pl. xxii. fig. 7 (1857); *id. Proc. Bost. Soc. Nat. Hist.* p. 88 (1859).

The body is convex along the middle line, with slight indications of a median dorsal keel. Head (in the Museum examples) smooth above, with its anterior margin distinctly emarginate; first segment of the thorax with its antero-lateral lobes broad and subtruncated; postabdomen slightly broader anteriorly, and equalling in length the four posterior thoracic segments taken together, composed of three segments, with lateral indications of a third, distal end of the terminal segment deeply emarginate, postero-lateral angles on each side prominent and acute. Eyes small. Antennules reaching to the distal end of the antepenultimate segment, with their basal joints greatly expanded, suborbiculate. Antennæ, when retracted, reaching or nearly reaching to the fourth thoracic segment; peduncle rather stout, with the last joint a little shorter than the penultimate joint; flagellum slender, 17–20-jointed. Epimera, of the second to fourth segments (in the Museum examples) linear, and occupying only a part of the lateral margins, of the fifth to seventh segments broader and occupying the whole length of the lateral margins; epimera of seventh segment with postero-lateral angles acute. Terminal plates of the operculum quadrate. Length of largest

example in the Museum collection $1\frac{1}{3}$ inch (34 millim.), breadth nearly $\frac{1}{3}$ inch (8 millim.).

Hab. West coast of N. America. Stimpson's type was dredged in the Straits of Da Fuca, opposite Fort Townsend (Capt. Murden).

There are in the British-Museum collection two males, preserved in spirit, from the Gulf of Georgia, near Orcas Island (Admiralty), and a small example, in spirit, from Vancouver Island (Boundary Commission), that I refer to this species.

IDOTEA HECTICA.

Oniscus hecticus, *Pallas, Spicil. Zool.* i. (fasc. 9) p. 61, pl. iv. fig. 10 (1772).

Asellus hecticus, *Olivier, Encycl. Méth.* iv. p. 255 (1789).

Idotea hectica, *Latr. Hist. Nat. Crust. et Ins.* vi. p. 371 (1803); *Lam. Hist. des Anim. sans Vert.* v. p. 160 (1818); ? *M.-Edw. Hist. Nat. Crust.* iii. p. 133 (1840); *id.* ? *Cr. in Règne Anim. de Cuv.* pl. lxix. fig. 1; *White, List Cr. Brit. Mus.* p. 95 (1847); *Lucas, Anim. artic. in Expl. Sci. Algérie, Cr.* p. 62 (1849); *Heller, Verhandl. zool.-bot. Vereins Wien,* xvi. p. 727 (1866); *Stalio, Att. Istit. Venet.* (ser. 5) iii. p. 1352 (1876–77).

Idotea viridissima, *Risso, Cr. des environs de Nice,* p. 136, pl. iii. fig. 8 (1816).

Gonotus viridis, *Rafinesque-Schmaltz, Précis des déc. Somiologiques,* p. 26 (1814).

Stenosoma hecticum, *Desm. Consid. Cr.* p. 291 (1825).

Armida viridissima, *Risso, Hist. Nat. Eur. mérid.* v. p. 109 (1826).

? Stenosoma viridula, *Costa, Cr. in Fauna del R. Napoli,* pl. iv. fig. 7 (1838); *Hope, Cat. Cr. Ital.* p. 26 (1851).

? Stenosoma eruginosa, *Costa, t. c.* pl. iv. fig. 6 (1838); *Hope, t. c.* p. 26 (1851).

Body elongated, narrow-oblong, but slightly narrowed towards the head, with a longitudinal median keel along the dorsal margin, which is obsolete on the terminal postabdominal segment. Anterior margin of the head with a deep, almost semicircular excavation; its antero-lateral lobes (in a dorsal view) broad and obtuse. Thoracic segments (the first excepted) of nearly equal length, with their posterior margins sinuated, and their postero-lateral angles scarcely acute; the first segment much shorter and deeply excavated anteriorly for the reception of the head. Postabdomen (in the Museum examples) about equalling in length the four posterior thoracic segments, with the first two segments quite distinct; the terminal segment somewhat depressed above, with a semicircular emargination at its distal end, and the postero-

lateral angles acute. Eyes very small, in the middle of the lateral margins. Antennules very slender, scarcely surpassing the antepenultimate peduncular joint of the antennæ, with their basal joints moderately dilated. Antennæ as long, or nearly as long, as the body without the postabdomen; peduncle with the last two joints elongated and subequal; flagellum with 14–24 joints. Epimera not evident in a dorsal view. All the legs very slender. Terminal plate of the opercular valves longer than broad, four-sided, with the posterior and outer angles rounded. The colour, according to M. Lucas, is a fine green, laterally margined and minutely punctulated with reddish. Length nearly $1\frac{1}{3}$ inch (33 millim.), breadth about $\frac{1}{4}$ inch (7 millim.).

This species inhabits the Mediterranean, but its range apparently is not confined to that region.

A male is in the Museum collection, preserved in spirit, from S. Europe (P. B. Webb), and a female, dry, from Tripoli (T. Ritchie).

In the Paris collection I have examined specimens (mostly females) from the Mediterranean (Roux), which are the types of M.-Edwards's description in the 'Hist. Nat. des Crustacés,' and which, like all others I have seen, have a 3-jointed postabdomen; also a male from Nice (M. Risso), a considerable series of both sexes and different sizes from Algeria (M. Lucas), and others without locality. There are also in the collection three specimens in somewhat imperfect condition from Bourbon (M. Breon), which I cannot distinguish specifically from *I. hectica.*

Pallas's types, it may be observed, were from the Atlantic.

IDOTEA LINEARIS.

Oniscus linearis, *Linn. Syst. Nat.* (ed. xii.) p. 1060 (1766); *Pennant, Brit. Zool.* iv. pl. xviii. fig. 2 (1777).

? Asellus linearis, *Olivier, Encycl. Méth.* iv. p. 254 (1789).

Idotea tridentata, *Latr. Gen. Crust. et Ins.* i. p. 64 (1806); *Lam. Hist. Anim. sans Vert.* v. p. 160 (1818); *Grube, Abh. schlesisch. Gesellsch. vaterl. Cultur*, p. 125 (1867)?

Idotea hectica, *Leach, Edinb. Encycl.* vii. p. 404, *nec Pallas.*

Stenosoma lineare, *Leach, Linn. Trans.* xi. p. 366 (1815); *Desm. Consid. Cr.* p. 299, pl. xlvi. fig. 12 (1825); *Guérin, Expl. dans la Morée,* iii. *Cr.* p. 49 (1832); *Brullé in Webb & Berthelot, Iles Canaries, Cr.* p. 18 (1836–44).

Idotea linearis, *Latr.* (pt.) *Hist. Nat. Cr. et Ins.* vi. p. 371 (1803); *M.-Edw. Hist. Nat. Cr.* iii. p. 132 (1840); *id. Cr. in Règne Anim. de*

Cuvier (*éd.* 3), pl. lxix. fig. 3; *Lucas, Anim. artic. in Expl. Sci. Algérie, Cr.* i. p. 61 (1849); *White, List Cr. Brit. Mus.* p. 94 (1847); *id. Cat. Brit. Cr. Brit. Mus.* p. 66 (1850); *id. Pop. Hist. Brit. Crust.* p. 224 (1854); *Burgersdijk, Annotat. Crust. indigenis,* p. 31 (1852); *S. Bate & Westwood, Brit. Sessile-eyed Cr.* ii. p. 388, fig. (1868); *Metzger, Naturh. Gesellsch. zu Hannover,* xx. p. 32 (1871); *Jahresb. der Commiss. zu wiss. Untersuch. des deutschen Meeres in Kiel,* p. 285 (1875); *Parfitt, Rep. Devon Assoc.* p. 255 (1873); *McIntosh, Ann. & Mag. Nat. Hist.* (ser. 4) xiv. p. 274 (1874); *Marine Invert. St. Andrews, Cr.* p. 151 (1875); *Bos, Bijd. Crust. Hedrioph. Nederl.* pp. 35, 71 (1874); *Hoek, Tijd. Nederl. Dierk. Vereenig.* (deel 3), p. 42 (1876); *Sim, List Cr. Aberdeen,* p. 11.

Idotea diodon, *Latr. Nouv. Dict. d'Hist. Nat.* xvi. p. 105 (1817).

Armida bimarginata, *Risso, Hist. Nat. Eur. mérid.* v. p. 109 (1826).

Idotea sexlineata, *Kröyer, Nat. Tidsskr.* (2 R.) ii. p. 88 (1846); *id. Atlas of Cr. in Gaimard's Voy. en Scand.* pl. xxvi. fig. 1; *Meinert, Nat. Tidsskr.* (3 R.) xi. p. 83 (1877), xii. p. 470 (1880).

Oniscus (Idotea) entomon, *Dalyell, Powers of Creator, Cr.* p. 229, pl. cxiii. fig. 10 (1851), *nec Linn.*

The body is narrow oblong, almost linear. The head has its anterior margin strongly excavated and its antero-lateral lobes broadly rounded, and is marked with a sinuated impressed line near the posterior margin. The thoracic segments are narrowest at the posterior margins, and the laterally-projecting epimera give a lobed appearance to the sides of the body. The terminal postabdominal segment is suboblong, but narrowing slightly in its distal portion; the distal extremity is truncated and tridentate, the postero-lateral lobes small, but somewhat more prominent than the median tooth. Eyes of moderate size. Antennules with the basal joint not greatly dilated. Antennæ in the adult very robust, nearly equalling the body in length, with the last two joints of the peduncle subequal, and each nearly or twice as long as the preceding. The epimera are small, and in the second to fourth thoracic segments appear, in a dorsal view, to occupy the *anterior* part of the lateral margin, in the fifth and sixth segments its middle part, and in the last segment its *posterior* part. The postero-lateral angles of the epimera of the sixth and seventh segments are acute. Each of the legs is armed with a strong and arcuate terminal claw, which is completely reflexible against the penultimate joint. The opercular plates present nothing remarkable. The length of the largest male in the collection is about 1½ inch (38 millim.), but average-sized examples do not exceed 1 inch (25 millim.).

This species is marked with olive or purple on a paler ground, the middle line of the back usually remaining pale. The median tooth of the posterior margin of the last segment is often obsolete.

This species occurs in the Mediterranean, on the shores of Great Britain and Ireland, Netherlands, Denmark, &c.; but its range is apparently not confined to the seas of Europe, since there are specimens said to be from Java in the Paris collection, and it is mentioned by M. Brullé in his list of the Crustacea of the Canaries.

There are male, female, and young specimens of this species in the British-Museum collection from Ilfracombe, Devon (Dr. Leach and Col. Montagu), three males from Beerhaven (Sir P. Egerton), three from Northumberland (purchased), one found among shrimps in the London market (F. Moore), and two or three, without special indication of locality, from European seas. All of the above are preserved dry.

Of specimens preserved in spirit, the Museum possesses two males from Ilfracombe (Dr. Leach), one from Ballinskelligs Bay, Ireland (Sir P. Egerton), and several without special indication of locality.

In the Paris collection are many specimens from Algeria (M. Lucas), the specimen (a small one without locality) that served as type to the description of M.-Edwards in the 'Hist. Nat. des Crustacés,' and others said to be from Java (M. Raynaud, Exp. de la Chevrette), with a specimen in fragmentary condition apparently referable to *I. marina*.

S. Bate and Westwood are, I think, in error in referring *Armida viridissima*, Risso, to this species; on the other hand, the description of *A. bimarginata* applies very well to those varieties of it in which the median terminal tooth of the postabdomen is developed.

To this species undoubtedly belongs a specimen in the Linnean Cabinet labelled *linearis*; the quadridentated appearance of the terminal postabdominal segment was caused apparently by the slightly projecting inferior and posterior angles of the opercular valves, which are visible from above in a dorsal view. The habitat "Surinam" is given in the 12th edition of Linnæus's work; but in Linnæus's copy in the possession of the Society the MS. words "*in Oceano Atlantico*" occur, with a line drawn through

them; hence it would seem that Linnæus was in doubt of the true habitat of the types of this species.

Here also, rather than to *I. marina*, must, I think, the *I. tridentata* of Latreille and Lamarck be referred, since the body is described as linear and the antennæ are as long as the body. The *I. tridentata* of Rathke is, however, more probably a variety of *I. marina*.

The *Idotea sexlineata* of Kröyer appears to represent a condition of *I. linearis* in which the antennæ are rather shorter and the median denticle of the posterior margin of the terminal segment is not developed. Specimens from Northumberland in the Museum collection closely resemble Kröyer's figure in these particulars, and in them the longitudinal dark lines on the dorsal surface of the body are clearly discernible.

IDOTEA INDICA. (Plate II. figs. 4 & 5.)

Idotea indica, *M.-Edwards, Hist. Nat. Crust.* iii. p. 131 (1840).
? Idotea Latreillei, *Guérin-Ménev. Icon. Cr. Règne Anim., Crust.* p. 32 (1829–44).

The body is smooth, nearly oblong, and moderately convex. Head with only very faint indications of a transverse groove on its upper surface, with the anterior margin very slightly excavated and the antero-lateral angles broadly rounded and not at all prominent. Thoracic segments (the first excepted) of nearly equal length; the first shorter, with its antero-lateral angles produced and forming broadly rounded lobes which do not reach to the eyes; second to fourth segments with their postero-lateral angles rounded, fifth to seventh with these angles subacute, but not prolonged backward. Postabdomen about as long as the five posterior thoracic segments; the first segment narrowed on the sides; the third (or terminal) segment not twice as long as broad, rather broader in the middle than at either end, with the sides slightly arcuated; the posterior margin very slightly emarginate and nearly straight. Antennules very short, scarcely reaching to the base of the antepenultimate joint of the peduncle of the antennæ, with their basal joints considerably dilated. Antennæ not as long as the head and thorax, with the last two joints of the peduncle nearly equal; flagellum a little shorter than the peduncle and 18-jointed. Legs moderately robust; the last pair with their penultimate joints thickened and considerably elon-

gated. Epimera small, in the second segment occupying, in a lateral view, only the anterior half of the lateral margins, in the second and third segments the middle portion of the lateral margins, in the fifth and sixth segments they reach nearly, and in the seventh segment quite, to the postero-lateral angles. Distal plates of the opecrulum four-sided, with their posterior margins truncated. Length about $1\frac{7}{12}$ inch (40 millim.).

Hab. Malabar (M. Dussumier).

The description is taken from the type in the collection of the Paris Museum, which is an adult male, and is the only specimen I have seen. In it the flagellum of one antenna is broken.

The *Idotea Latreillei* of Guérin-Méneville, from the Cape of Good Hope, is apparently distinguished merely by the longer flagellum of the antennæ (which is longer than the peduncle); the legs are described as slender, and there is a deep longitudinal median groove on the upper surface of the terminal postabdominal segment. It may be distinct; but I am inclined to regard this species as identical with *I. indica*. *I. indica* is distinguished from *I. linearis* by its much broader body, non-projecting epimera, and much shorter antennæ.

III. *Postabdomen composed of two distinct segments (visible in a dorsal view).*

The species of this section of the genus may be distinguished as follows:—

* *Terminal segment emarginate at its distal end.*

Oblong-ovate: epimera well developed, in the sixth thoracic segment occupying the whole of the lateral margins of the segment. 1. *I. ungulata* (Pallas).

Slender, with subparallel sides: epimera very narrow, of the sixth segment occupying a very small portion of the thoracic segment. 2. *I. elongata*, Miers.

Slender: epimera forming with the laterally produced margins of the thoracic segments distinct rounded lobes.
3. *I. lobata*, White (*ined.*), Miers.

** *Terminal segment subtriangulate at its distal end.*

Suboblong: epimera narrow.
4. *I. Peronii*, M.-Edwards.

IDOTEA UNGULATA.

Oniscus ungulatus, *Pallas, Spicil. Zool.* ix. p. 62, pl. iv. fig. 11 (1772).
Idotea ungulata, *Lam. Hist. Anim. sans Vert.* v. p. 160 (1818).
Idotea Lalandii, *M.-Edwards, Hist. Nat. Crust.* iii. p. 132, pl. xxxi. fig. 7 (1840); *Krauss, Südafrik. Crust.* p. 61 (1843).
Idotea affinis, *M.-Edw. Hist. Nat. Cr.* iii. p. 133 (1840); *Krauss, Südafrik. Crust.* p. 61 (1843); *White, List Cr. Brit. Mus.* p. 95 (1847); *Heller, Cr. in Reise der Novara*, p. 130 (1865); *Miers, Catalogue of New-Zealand Crustacea*, p. 93 (1876); *Thomson, Trans. New-Zeal. Inst.* xi. p. 232 (1879).
Idotea Edwardsii, *Guérin-Méneville, Icon. Cr. R. Anim.*, texte Cr. p. 33 (1829–44).
Idotea nitida, *Heller, Verhandl. zool.-bot. Vereins Wien*, p. 497 (1861); *id. Cr. in Reise der Novara*, p. 131, pl. xii. fig. 1 (1865).

Body oblong, moderately convex, and nearly smooth. Head with the frontal margin very slightly concave, but with a slight depression in the middle; antero-lateral angles usually but little prominent, smooth above, or with faint indications of an impressed curved line near the posterior margin. Segments of the thorax smooth; the first the shortest, its antero-lateral processes obtuse; the postero-lateral angles of the first to third segments rounded, of the fourth to seventh segments rectangular or acute. Postabdomen somewhat depressed towards its distal extremity, smooth, with lateral sutures indicative of two coalescent segments; terminal segment with the lateral margins straight to within a short distance of the postero-lateral angles, which are either obtuse or acute; distal end emarginate. Eyes small, black. Antennules not reaching to the distal end of the penultimate joint of the peduncle of the antennæ. Antennæ when retracted not reaching to the posterior margin of the fourth thoracic segment, and often much shorter; last two joints of the peduncle short and subequal; flagellum longer than the peduncle, with 12 to 28 joints. Epimera rather narrow, in the second and third thoracic segments scarcely occupying more than half the length of the lateral margins, in the fourth to seventh segments occupying their whole length; only the last two epimera on each side have their postero-lateral angles acute. The legs are robust; the fourth to seventh pairs of legs have their posterior and outer angles of the merus and ischium produced, and in adult examples spiniform. The posterior plates of the opercular valves are buadrate and nearly square. The length of the largest example

in the Museum collection exceeds $2\frac{1}{4}$ inches (58 millim.), but average-sized examples measure about $1\frac{3}{4}$ inch (45 millim.).

This species appears to be widely distributed throughout the Antarctic or, rather, Austral circumpolar region. It occurs also in the Indian Ocean (Pallas), Southern Australia, and on the Eastern coasts of S. America northward to Rio de Janeiro, and on the Western coasts as far north as Talcahuano (Chili).

The above description is drawn up from specimens, formerly designated *I. affinis*, in the British Museum.

There are examples of both sexes, and preserved dry, in the collection without definite locality, designated by Leach *I. elevata*; others from Australia (Earl of Derby); some young examples from S. Australia (purchased), a specimen from Tasmania, a male and female from Flinders Island (Surg. Rayner, H.M.S. 'Herald'); two males and a female from the Auckland Islands (Admiralty), designated by White *I. longicornis*; a male of large size and two females from New Zealand (purchased); two smaller examples from Collingwood, Nelson County, New Zealand (H. Drew); a male of large size, said to come from the Cape of Good Hope. All of the above preserved dry. Also two males, preserved in spirit, from the Falkland Islands (Admiralty).

In the Paris collection I have examined the types of *I. Lalandii* from the Cape of Good Hope (M. de Lalande), which are of very large size ($2\frac{1}{3}$ inches, 59 millim.), having the epimera as described above, and the postero-lateral angles of the fourth to seventh thoracic segments slightly produced and acute. Also the types of *I. affinis*, M.-Edwards, from Rio de Janeiro (M. Freycinet), in which the antennæ are now imperfect. These specimens are of rather small size; but the differences between them and *I. Lalandii* are not greater than I have observed between examples from one and the same locality of this species, and I have only marked the citation with doubt on account of the wide-removed habitat. There is, however, a specimen of larger size from South America (M. A. Edwards). Specimens are in the collection, also, from Talcahuano, Chili (M. Jacquinot), one from Auckland, several from New Zealand (Exp. de la Zélée, Quoy and Gaimard, M. Lavoux), and others without locality.

In the large series that has been under my observation I have noticed considerable variation in the length of the flagella of the antennæ, the robustness of the legs, and the depth of the posterior notch of the terminal segment and the acuteness of its postero-

lateral angles. In the very large specimens from the Cape of Good Hope the antennæ are relatively shorter, the legs more robust, and the posterior notch shallower, but this appears merely to be due to the greater size and age of the specimens. In the smaller specimens from the Cape these characters disappear.

In a great number of New-Zealand specimens examined by Mr. Thomson that naturalist found the length to vary from 1 to over 2½ inches (35 to 65 millim.), and the number of joints in the antennal flagellum from 16 to 32.

The *Oniscus ungulatus* of Pallas has generally been considered to be synonymous with *I. linearis*, but the description and figure agree far better with *Idotea Lalandii*. Pallas says that the head is truncated anteriorly, the three anterior thoracic segments have their postero-lateral angles rounded, the posterior segments are subimbricated, with acute angles. The epimera of the second and third segments do not reach to the posterior margin of the segment. There is a single distinct postabdominal segment besides the terminal segment, which is marked on each side with a double stria (or suture), and is excised and bidentate at its posterior margin (*i. e.* with prominent postero-lateral angles). Antennæ of moderate size, 18-jointed; in the figure they are represented as very short, not reaching beyond the posterior margin of the second thoracic segment, and the joints of the peduncle short, scarely distinguishable from the flagellum. Pallas gives the Indian Ocean as the locality of his specimens.

IDOTEA ELONGATA.

Idotea elongata, *White, List Crust. Brit. Mus.* p. 95 (1847), sine desc.; *Miers, Ann & Mag. Nat. Hist.* (ser. 4) xvii. p. 225 (1876); *Catalogue of New-Zeal. Crust.* p. 93, pl. ii. fig. 3 (1876).

Body elongate, almost linear, smooth, with the dorsal surface very convex, so that the animal appears almost cylindrical in a dorsal view. Head with the anterior margin scarcely excavated, but with a slight depression in the middle between the antennules; antero-lateral angles not prominent. Segments of the thorax (in the adult male) usually longer than broad, first segment with the antero-lateral lobes prominent and obliquely truncated. Postabdomen about equalling the 3½ posterior thoracic segments in length, having usually indications of a lateral suture on each side at some distance from the base of the terminal segment, which is rather depressed above, with subparallel sides,

rounded postero-lateral lobes, and a moderately deep rounded notch at its distal end. Eyes small. Antennules scarcely reaching to the distal end of the antepenultimate joint of the antennæ, which have a short peduncle, the last two joints of which are subequal and each but little longer than the antepenultimate joint; flagellum 18–22-jointed; when retracted the antennæ do not reach beyond the posterior margin of the fourth thoracic segment. Legs very slender. Epimera scarcely visible in a dorsal view; in a lateral view they are very narrow, linear, and the last pair only reach to the postero-lateral angles of the segment with which they are articulated. Terminal plates of the opercular valves somewhat longer than broad, four-sided, with the distal ends truncated or very slightly emarginated. Length of a full-sized male about 2 inches (50 millim.), breadth about $\frac{1}{4}$ inch (7 millim.).

Specimens, apparently males, are in the Museum collection from the Auckland Islands (Antarctic Exped.), preserved dry; and a good series of both sexes, preserved in spirit, from the Falkland Islands (Antarctic Exped.).

When I drew up the original description I had not observed that the Falkland-Island examples were of the same species, and basing my diagnosis on the dried examples only, I fell into one or two inaccuracies: thus the head is not generally coalescent with the first thoracic segment, and the thoracic segments not always longer than broad. In females with fully-developed brood-pouches, the second to fourth thoracic segments appear laterally dilated in a dorsal view.

In the Paris collection there are six specimens from Auckland.

IDOTEA PERONII. (Plate II. figs. 6 & 7.)

Idotea Peronii, *M.-Edw. Hist. Nat. Cr.* iii. p. 133 (1840).
Idotea distincta, *Guérin-Méneville, Icon. Règne Anim., Cr.* p. 33 (1829–44).

Body narrow-oblong rather than oval, not carinated, nearly smooth. Head emarginate anteriorly, the middle of the notch straight; the antero-lateral angles rather prominent and rounded. First thoracic segment with the antero-lateral lobes rather broad, and not reaching nearly to the eyes. Postabdomen as long as the four or five posterior thoracic segments; terminal segment with two small sutures on each side near the base (indicative of coalescent segments) and with subparallel sides, distal end usually broadly triangulate, and apex subacute. Eyes of mode-

rate size. Antennules scarcely reaching to the base of the antepenultimate joint of the peduncle of the antennæ, with their basal joints considerably dilated. Antennæ with the joints of the peduncle short, the last two subequal, and each but little longer than the antepenultimate joint; flagellum 16–21-jointed and longer than the peduncle. The epimera are narrow, and in the second, third, and fourth thoracic segments scarcely occupy more than half the length of the lateral margins; in the fifth segment they reach nearly, and in the sixth and seventh segments quite, to the postero-lateral angles, and in these segments are of a more or less triangulate shape. The legs are very slender. The terminal plates of the opercular valves are three-sided, with their outer margins curving to the distal extremity, which is subacute or blunt. Length of the largest male about $1\frac{5}{6}$ inch (48 millim.), breadth nearly $\frac{5}{12}$ inch (10 millim.); but most of the specimens are much smaller.

In the British-Museum collection are specimens:—from York Peninsula, Australia, a female, preserved dry (G. F. Angas); Tasmania, a male, dry (Ronald Gunn); and a small example, also in a dry state, from Flinders Island, Bass's Straits (Surgeon Rayner, H.M.S. 'Herald'); also a good series of males and females from Flinders Island, preserved in spirit (Dr. Milligan).

The examination of the type of M.-Edwards's *Idotea Peronii* (a male, from King's Island, M. Péron), in the collection of the Paris Museum, seems to show that M. Guérin's *Idotea distincta* cannot be specifically distinct. In M.-Edwards's type there are in reality *two* lateral sutures (not a single one as stated) on the sides of the terminal segment near its base. The only distinctive character is the more rounded apex of the terminal segment in *I. Peronii*, which, in this instance, is probably due to the contraction of the specimen (which was formerly in a dry state), and it is not, moreover, a character of much importance. M. Guérin's types were from the Cape of Good Hope. In the Paris collection are a considerable series from Melbourne.

The description was taken from specimens in the British Museum, with which M. Milne-Edwards's type, now somewhat shrivelled and with imperfect antennæ, has been compared. In Australian specimens the apex of the terminal segment is often just of the form described by Guérin-Méneville in *I. distincta*.

In a small example from Flinders Island in the British Museum the head is less distinctly emarginated, the terminal segment is

more acuminated at its distal end, and the posterior epimera are small.

This species in external form nearly resembles *I. stricta*, Dana, with which I should have considered it identical, but for the bi-articulate postabdomen, the terminal segment of which is marked near its base with two sutures. The antennal flagellum is more numerously jointed.

The description is taken from examples in the Museum collection, which I have compared with the Paris type. They scarcely differ from the description of Guérin-Méneville, except in the longer antennæ, whose flagellum is nearly always longer than the peduncle.

In the brood-pouches of some of the females from Flinders Island are numerous young examples, about $\frac{1}{6}$ inch (4 millim.) in length.

IDOTEA LOBATA. (Plate II. figs. 8 & 9.)

Idotea lobata, *White, List Cr. Brit. Mus.* p. 96 (1847), descript. nullâ.

In this remarkable species the body is elongated and moderately convex, the segments of the thorax are laterally produced, and with the greatly developed epimera form lateral prolongations that are perfectly distinct from one another even at their bases, and are more or less rounded at their apices. The head has its frontal margin nearly straight, and its antero-lateral angles are not prominent. The thoracic segments are short and nearly smooth above. The postabdomen about equals the four posterior thoracic segments in length; the terminal segment has straight and subparallel sides, and is emarginate at its distal extremity, with the postero-lateral angles rounded. Eyes large. The antennules apparently reach almost to the extremity of the penultimate peduncular joint of the antennæ, and have their basal joints moderately dilated. Antennæ short, when retracted not reaching beyond the posterior margin of the fourth thoracic segment, with the last two joints of the peduncle subequal, short, but longer than the preceding; flagellum with about 10 joints. The epimera, in a dorsal view, are large and occupy the whole of the lateral margins of the produced thoracic segments. Legs slender and nearly naked. Terminal plates of the opercular valves four-sided, but little longer than broad, with the distal ends truncated. Length rather more than $\frac{1}{3}$ inch (10 millim.), breadth nearly $\frac{1}{6}$ inch (4 millim.).

The single example, in dry state, in the collection is unfortunately without any definite locality.

In its widely-separated and laterally-projecting epimera it is very unlike any other species of the genus with which I am acquainted. M. Lucas, indeed, in his figure of *I. algirica*, exhibits a somewhat similar structure of the epimera, but the figure is probably exaggerated. *I. algirica*, moreover, has a 3-jointed postabdomen and a truncated terminal segment; and I have considered it synonymous with *I. metallica* on the authority of specimens in the Paris collection.

IV. *Postabdomen with all the segments (in a dorsal view) consolidated and forming a single piece.* (Leptosoma, *Risso*; Crabyzos, *S. Bate.*)

The species of this section may be distinguished as follows:—

a. *Terminal segment not emarginate at its distal end.*

Suboblong, with straight subparallel sides; terminal segment subacute: epimera of the second to fourth segments not distinguishable; head with a dorsal tubercle.
1. *I. carinata*, Lucas.

Suboblong; sides and thoracic segments straight; terminal segment subtriangulate at distal end: epimera all distinct; head without a dorsal tubercle. 2. *I. stricta*, Dana.

Narrow; lateral margins of the thoracic segments angulated; terminal segment acute or subacute: epimera very small; head without a dorsal tubercle. 3. *I. acuminata* (Leach).

Very narrow and elongated; sides of thoracic segments straight; terminal segment produced and acuminated: epimera very small; head without a dorsal tubercle. 4. *I. longicaudata* (S. Bate).

b. *Terminal segment emarginate at its distal end.*

Oblong-ovate: epimera distinct and well developed; head with a dorsal tubercle. 5. *I. Lichtensteinii*, Krauss.

IDOTEA CARINATA.

Idotea carinata, *Lucas, Anim. artic. in Expl. Sci. Algérie*, i. *Cr.* p. 60, pl. vi. fig. 1 (1849).

Body oblong-oval, moderately elongated, strongly carinated in the middle dorsal line. Head with the anterior margin distinctly excavated, the antero-lateral angles nearly right angles; the upper surface armed with a strong tubercle, which is more or less di-

stinctly bilobated at its apex. Thoracic segments nearly smooth above, the first shortest, with its anterior margin deeply excavated and the broadly-rounded antero-lateral lobes reaching to the eyes; postero-lateral angles of all the segments subacute. Postabdomen strongly carinated in the middle line; the keel reaching quite to the posterior margin, uniarticulate, with three very distinct lateral fissures (indicative of coalescent segments), with the sides slightly convergent to the distal extremity, which rounds off to a small median cusp or point. Antennules not reaching to the distal end of the antepenultimate joint of the antennæ, which do not usually exceed half the body in length; peduncle with the last two joints subequal and but little longer than the preceding; flagellum shorter than the peduncle, and 4- to 6-jointed. The epimera of the three posterior thoracic segments only are visible in a dorsal view, and in these they are rather broad, with the postero-lateral angles not acute, and are not prolonged beyond the posterior margin of the segments. Legs very slender, almost filiform. Distal plate of the opercular valves almost triangulate, with the apex subacute. The colour (according to M. Lucas) is deep green; all the thoracic segments with their posterior and lateral margins margined with yellow; antennæ yellowish; antennules greenish yellow. Length $\frac{5}{6}$ inch (21 millim.), breadth nearly $\frac{1}{4}$ inch (6 millim.).

I. carinata does not, so far as I am aware, extend beyond the shores of the Mediterranean.

The description is taken from specimens in the Paris collection from Algeria (Lucas), one of which has been retained for the British Museum, but the colour and measurements are from M. Lucas's work.

This species is very distinct from most of the genus, and in several points approaches certain species of the genus *Edotia*, from which it is distinguished by the distinct epimera of the posterior thoracic segments and subparallel sides of the body. There is no distinct oblique line on the basal plates of the operculum.

M. Lucas mentions the occurrence of this species at Bona and Oran.

IDOTEA ACUMINATA.

Stenosoma acuminatum, *Leach, Edinb. Encyl.* vii. p. 433; *id. Trans. Linn. Soc.* xi. p. 366 (1815).

Idotea lanciformis, *Risso, Cr. de Nice*, p. 136, pl. iii. fig. 11 (1816).
Leptosoma lanceolata, *Risso, Hist. Nat. Eur. mérid.* v. p. 107 (1826).
Leptosoma appendiculata, *Risso, Hist. Nat. Eur. mérid.* v. p. 107, pl. v. fig. 23 (1826); *Hope, Cat. Cr. Ital.* p. 26 (1851).
Leptosoma capito, *Rathke, Beitr. in Mém. Sav. étrang. St. Pétersb.* iii. p. 384, pl. vi. figs. 7–9 (1837).
Idotea appendiculata, *M.-Edw. Hist. Nat. Cr.* iii. p. 135 (1840); *White, List Cr. Brit. Mus.* p. 95 (1847); *Cat. Brit. Cr. B. M.* p. 66 (1850); *Pop. Hist. Brit. Cr.* p. 224, pl. xii. fig. 3 (1857); *Lucas, Anim. artic. in Expl. Sci. Algérie*, p. 62 (1849); *Heller, Verh. zool.-bot. Gesellsch. Wien*, xvi. p. 731 (1866); *S. Bate & Westwood, Brit. Sessile-eyed Crust.* ii. p. 396, fig. (1868); *Parfitt, Rep. Devon Assoc.* vi. p. 255 (1873); *Stalio, Att. Istit. Venet.* (ser. 5) iii. p. 1354 (1876–77).
Idotea acuminata, *White, List Cr. Brit. Mus.* p. 95 (1847); *Cat. Brit. Crust. B. M.* p. 66 (1850); *Pop. Hist. Brit. Crust.* p. 224 (1857); *S. Bate & Westwood, Brit. Sessile-eyed Crust.* ii. p. 394, fig. (1868); *Parfitt, Rep. Devon Assoc.* vi. p. 255 (1873).
Idotea angustata, *Lucas, Anim. artic. in Expl. Sci. Algérie*, p. 63, pl. v. fig. 3 (1849); *nec Nicolet.*
Idotea capito, *Lucas, Anim. artic. in Expl. Sci. Algérie, Cr.* p. 63 (1849); *Heller, Verh. zool.-bot. Gesellsch. Wien*, xvi. p. 730 (1866); *Czerniavsky, Mat. Zoograph. ponticam*, pp. 84, 130 (1868); *Stalio, Att. Istit. Venet.* (ser. 5) iii. p. 1355 (1876–77).
Leptosoma lanceforme, *Hope, Cat. Cr. Ital.* p. 27 (1851).

Body narrow, elongated, moderately convex, with indications of a longitudinal median dorsal carina. Head with its anterior margin somewhat excavated, and its antero-lateral angles rather prominent. First four segments of the thorax each widest in the middle, and with their lateral margins (in a dorsal view) more or less angulated; the posterior segments of the thorax are widest at or near their postero-lateral angles. Postabdomen ovate-lanceolate, with the lateral margins at first straight and then curving regularly to the distal extremity, which is subacute or acute, or even acuminated, and with more or less distinct traces of lateral sutures near its base, indicative of two coalescent segments. Eyes small, placed in the middle of the lateral margins. Antennules do not reach the extremity of the antepenultimate joint of the peduncle of the antennæ, with their basal joints moderately dilated. Antennæ reaching sometimes to the posterior margin of the sixth thoracic segment; the last two joints of the peduncle slender, subequal, and each longer than the preceding; flagellum about 19-jointed and longer than the peduncle. Legs

very slender, subequal. The epimera (in a dorsal view) are very small, and in the second to fourth segments occupy the middle of the lateral margins; in the fifth and sixth segments they are placed near to, and in the seventh segment quite at the postero-lateral angle of the segment; in the last two segments they are of nearly triangular form. The terminal plates of the operculum are considerably longer than broad, and rounded at their distal ends. Length of the largest example in the Museum collection about 1 inch (25 millim.), breadth rather less than $\frac{1}{4}$ inch (5 millim.).

This is a very variable species, and I have been obliged to unite under one name several types that have usually been considered distinct.

It occurs on the shores of the Mediterranean and Adriatic, in the Black Sea, on the south British coasts, and northward apparently as far as the island of Cumbray on the Clyde.

Dr. Leach's designation of *I. acuminata* may apply to what may be considered the typical form of this species, in which the body is less distinctly carinated, the epimera less distinctly angulated, and the terminal segment lanceolate, with the sides rounding off to the distal extremity, which is acute or subacute, but not produced and acuminated.

Besides Leach's typical specimen (which is in very bad condition), there is but a single specimen, from Tripoli, in the British-Museum collection presenting these characters.

In the Paris collection I have examined five examples from Nice (types of Milne-Edwards's description of *I. appendiculata*, Risso); also a good series from Algeria without special locality (M. Lucas), designated *I. angustata*; and three from the neighbourhood of Constantine (M. Lucas), labelled *I. capito*, Rathke.

IDOTEA ACUMINATA, var. LANCIFORMIS, *Risso*?

This variety nearly resembles the typical *acuminata*, but the terminal segment is angulated, not rounded on the sides towards the distal extremity, which thus appears more or less triangulate.

Two specimens from Marseilles and one from Dalmatia (Dr. Heckel), in the British-Museum collection, belong here.

IDOTEA ACUMINATA, var. APPENDICULATA, *Risso*.

Under this designation may be grouped the specimens having the body more depressed, flattened on the sides, but strongly

longitudinally carinated in the middle line; the epimera very prominently and distinctly angulated, and the terminal segment rounded on the sides, but produced and acuminated at the distal end.

There are in the British-Museum collection two specimens from Tripoli.

In the Paris collection I have examined five examples from Bona and one from near La Calle (M. Lucas); also one found amid Algerian specimens of *I. hectica* (Lucas), in which the tip of the terminal segment has been broken off.

Risso apparently figures a specimen of this variety under the name of *appendiculata*; therefore his name is retained for it.

IDOTEA ACUMINATA, var. LANCIFER, *Leach* (*ined.*).

This variety is distinguished by the form of the terminal post-abdominal segment, which is widest at a point distant about two thirds from the base, after which it is suddenly contracted, the terminal portion or cusp being narrow-linear and produced. The body is carinated, as in var. *appendiculata*, but the epimera are less distinctly angulated.

The only specimens I have seen presenting these characters are two males and a younger example from Devon, Sidmouth (Dr. Leach), designated *I. lancifer* by Leach and *I. appendiculata* by White, and a female from Ilfracombe (Mr. Gosse) in the British Museum; but a considerable approach to them exists in the variety designated *I. lanciformis* by Risso.

This variety is figured by White, S. Bate and Westwood (*loc. cit.*) as *Idotea appendiculata*.

IDOTEA STRICTA.

Idotea stricta, *Dana*, *U.S. Expl. Exp.* xiv. *Cr.* ii. p. 704, pl. xlvi. fig. 7 (1853); *S. Bate, in Lord's Naturalist in Brit. Columbia*, ii. p. 282 (1866)?

This species is described by Prof. Dana as narrow, with the front excavate; head a little transverse. The surface is not distinctly granulate. Postabdomen uniarticulate, longer than half the cephalothorax, narrow-oblong (length more than twice the breadth), with a suture on each side near the base; lateral margins a little excavate or concave, extremely triangulate or subacute. Antennules scarcely reaching to the penultimate joint of

the peduncle of the antennæ, which are about half as long as the body; flagellum shorter than the peduncle, 10-jointed, naked. Epimera occupying only part of the margin of each thoracic segment. Legs sparingly hirsute below. Length 0·86 inch, breadth 0·17, ratio 5 : 1.

New South Wales, Australia (Dana).

Were it not for the uniarticulate postabdomen, I should consider it identical with *I. Peronii.*

Mr. S. Bate refers, without any description, specimens from Esquimalt Harbour, British Columbia, to this species; it is far more probable that they belong to *Idotea ochotensis* or *I. Whitei.*

IDOTEA LONGICAUDATA.

Crabyzos longicaudatus, *S. Bate, Proc. Zool. Soc.* p. 504, pl. xli. fig. 7 (1863).

The body is elongated and slender, smooth, with the sides nearly parallel. The head is partially coalescent with the first thoracic segment, and about equals it in length; the dorsal surface of the thoracic segments is nearly flat, while the margins with the epimera stand nearly perpendicular to them; the last two segments are rather shorter than the preceding. The head has its anterior margin excavated; but the median part behind the antennules is straight. The postabdomen is as broad at base as the posterior thoracic segments, with the sides at first nearly parallel and afterwards divergent; the distal extremity is acuminated, terminating in a long cusp or point. Eyes small, round, placed near the antero-lateral angles. Antennules slender, with the basal joints not dilated. Antennæ nearly four times as long as the antennules, but not reaching, when retracted, to the posterior margin of the third thoracic segment; the first two of the peduncular joints are very short, the last three elongated and of nearly equal length; flagellum shorter than the peduncle, and 12–14-jointed. The legs are slender, feeble, and nearly naked, but the first pair are more elongated and robust than the rest; the epimera or coxal joints are quite small, and, in a lateral view, occupy only a very small part of the lateral margins; the dactyli of all are furnished with a small accessory claw. The opercular valves do not reach beyond the beginning of the long terminal cusp of the postabdomen; their terminal plate is longer than broad, suboblong. Colour is said to have been apple-green.

darker along the line of the alimentary canal, with numerous minute spots over the surface generally. Length of the larger example about $1\frac{2}{3}$ inch (43 mm.).

Loc. Gulf of St. Vincent, S. Australia (G. F. Angas).

Two specimens are in the British-Museum collection: the larger is a female, with ova; the smaller, which is $1\frac{1}{6}$ inch in length (30 mm.), is a male. In the figure cited the antennæ are incorrectly drawn, and the anterior legs are too much enlarged.

This remarkable species cannot, I think, be generically separated from *Idotea*; in its general form and the very small development of the coxal joints or epimera it is more nearly allied to *I. elongata* than to any of the species with uniarticulate postabdomen. In both examples the suture separating the head from the first thoracic segment is distinct at the sides; in the smaller it is even faintly traceable across the dorsal surface.

IDOTEA LICHTENSTEINII.

Idotea Lichtensteinii, *Krauss, Die Südafrik. Crust.* p. 62, pl. iv. fig. 4 (1843).

In this species the body is somewhat elongated, finely granulated above, carinated longitudinally. The head is firmly encased in the first thoracic segment, has its anterior margin three-toothed, and has a somewhat deflexed blunt lobe on its upper surface, which projects in the middle beyond the frontal margin. The postabdomen is posteriorly somewhat conically contracted, and is as long as the thorax is broad; it has three sutures on each side near its base, and its posterior margin is notched, with the postero-lateral angles rounded. The antennules reach to the end of the penultimate joint of the peduncle of the antennæ, which reach, when retracted, to the middle of the third thoracic segment. Legs slender, compressed; the first pair with the penultimate and antepenultimate joints somewhat hairy; the rest smooth, with a feeble tooth on the under edge of the penultimate joint. The epimera reach to the posterior margins of the segments, to which they are articulated; the three anterior are narrow, and the three posterior broad and truncated. Length rather more than 1 inch English (about 26 mm.), breadth nearly 7 lines (14 mm.).

Cape of Good Hope; Table Bay (in algæ).

I have seen no specimens of this species, which in many of its

characters approaches *Edotia*, from which it is distinguished by the distinct epimera.

EDOTIA.

Edotia, *Guérin-Méneville, Icon. Règne Animal, Cr.* p. 34 (1829–44); *Dana, Amer. Journ. of Sci. & Arts,* (ser. 2) xiv. p. 300 (1852); *id. U.S. Expl. Exp.* xiv. (*Cr.* 2), p. 697 (1853).

Anisonotus, *White, List Crust. Brit. Mus.* p. 97 (1847), descript. nullâ.

Desmarestia, *Gay, Hist. de Chile, Zool.* iii. *Cr.* p. 284 (1849); *Dana, t. c.* p. 1595 (1853).

? Epelys, *Dana, Amer. Journ. of Sci. & Arts,* (ser. 2) viii. p. 426 (1849), xiv. p. 300 (1849); *id. ? U.S. Expl. Exp.* xiv. (*Cr.* 2) pp. 697, 705 (1853); *? Harger, Isopoda in Rep. U.S. Fish Comm.* pt. vi. p. 357 (1880).

Synidotea, *Harger, Amer. Journ. of Sci. & Arts,* (ser. 3) xv. p. 374 (1878); *id. Isopoda in Rep. U.S. Fish Comm.* pt. v. p. 350 (1880).

Body rather convex, usually of a firmer and more solid structure than in *Idotea*, more or less ovate, with the sides narrowing rapidly from the third or fourth thoracic segment to the distal end of the postabdomen. Postabdomen uniarticulate or biarticulate. Antennules slender, longer or shorter than the head. Antennæ either short, with an obsolete or with a minute rudimentary flagellum, or well developed, with the flagellum multiarticulate. Epimera not distinct, and not evident in a dorsal view, *i. e.* not distinctly articulated with the thorax. Legs moderately robust; the three anterior pairs with the penultimate joints or palms not greatly dilated; dactyli strong. Operculum with the basal or proximal plates having their outer surface crossed by an oblique raised line (in the species I have examined).

§ *Antennæ well developed, with the flagellum composed of several joints. Postabdomen uniarticulate.* (Synidotea.)

The only distinction that can be cited to separate the species of *Synidotea* from *Edotia*, viz. the long antennæ with more numerously articulated flagellum, is, I think, scarcely of generic importance, since the length of the flagellum is subject to considerable variation, even in different individuals of a single species. In *Edotia* (*Synidotea*) *nodulosa* the flagellum is only about 9-jointed, the last two joints being very minute.

The species of this section of the genus may be distinguished as follows :—

a. *Terminal segment emarginate at its distal end.*

Head with a median notch in its anterior margin; terminal plates of the valves of the operculum triangulate, acute at apex.
1. *E. bicuspida* (Owen).

Head with the anterior margin entire; terminal plates of the valves of the operculum four-sided, truncated at apex.
2. *E. hirtipes* (M.-Edw.).

b. *Terminal segment not emarginate at its distal end.*

Head with its anterior margin notched; terminal plates of the opercular valves triangulate. 3. *E. nodulosa* (Kröyer).

EDOTIA BICUSPIDA.

Idotea bicuspida, *Owen, Crust. in Zool. Capt. Beechey's Voyage*, p. 92, pl. xxvii. fig. 6 (1839); *Streets & Kingsley, Proc. Essex Instit.* ix. p. 108 (1877); *Miers, Crustacea in Markham's Polar Reconnaissance* p. 342 (1881).

Idotea consolidata, *Stimpson, Pr. Cal. Acad. Nat. Sci.* i. p. 89; *id. Boston Journ. Nat. Hist.* vi. p. 503 (1853).

Idotea marmorata, *Packard, Mem. Boston Soc. Nat. Hist.* i. (pt. 2) p. 296, pl. viii. fig. 6 (1867); *Whiteaves, Canad. Nat.* p. 262 (1875).

? Idotea rugulosa, *Buchholz, Cr. in Zweite deutsche Nordpolarf.* ii. p. 285, note (1874).

Idotea pulchra, *Lockington, Pr. Cal. Acad. Sci.* vii. (pt. i.) p. 45 (1877).

Synidotea bicuspida, *Harger, Pr. U.S. Nat. Mus.* ii. p. 160 (1879); *id. Isopoda in Rep. U.S. Fish Commission*, pt. vi. p. 352 (1880).

Synidotea incisa, *G. O. Sars, Arch. f. Math. og Naturvidenskab.* iv. p. 433 (1880).

Body ovate; in the largest examples rather depressed. Head transverse; anterior margin nearly straight, with a small median notch; its antero-lateral angles prominent and nearly right angles; its upper surface very uneven, the inequalities defined by strongly marked depressions. Thoracic segments short, of nearly equal length in the middle line, where they are marked above with two short transverse raised lines, and rugose on the sides midway between the median line and lateral margins; first three or four segments with the antero-lateral and postero-lateral angles broadly rounded; the following segments with the postero-lateral angles nearly right angles. Postabdomen in the adult about equalling the four posterior thoracic segments in length, and

about as long as broad at base, nearly smooth, moderately convex, with the lateral margins converging regularly to the distal extremity, which has a small shallow rounded notch, and with a single lateral suture on each side at base, indicative of a coalescent segment. Eyes large, prominent. Antennules in the adult scarcely reaching beyond the base of the penultimate peduncular joint of the antennæ, somewhat remote from one another, with their basal joints very small. Antennæ about half as long as the body; the last peduncular joint longer than the preceding; flagellum 14–17-jointed. Legs moderately robust, rather thinly pubescent; claws slender. Terminal plates of the operculum triangulate, and but little longer than broad at base. Length of the largest male about 1 inch (25 mm.), breadth nearly $\frac{1}{2}$ inch (12 mm.).

E. bicuspida is a widely distributed inhabitant of the boreal and Arctic regions; its ascertained range is from Spitzbergen to Behring's Straits, and southward along the eastern coast of North America to the Gulf of St. Lawrence.

There is in the Museum collection a dried example without locality (Sir J. Richardson); six specimens in spirits, males and young, from the Matyushin Shar (Capt. A. H. Markham); and two adult females and two young in spirit without locality (Haslar Hospital).

Capt. Markham's specimens still present traces of the beautiful coloration mentioned by Mr. Lockington, having purplish cloudings on a lighter ground.

The identification of *Idotea pulchra* with *E. bicuspida* is made by Mr. Lockington himself in a MS. marginal note of the copy of his paper communicated to the author.

I can see no sufficient reason for separating either the *Idotea rugulosa*, Buchholz, or the *Synidotea incisa* of Sars, both from Spitzbergen, from this species.

EDOTIA NODULOSA.

Idotea nodulosa, *Kröyer, Naturhist. Tidsskr.* (2 R.) ii. p. 100 (1846); *id. ? Atlas of Crust. in Voy. en Scand.* pl. xxvi. fig. 2; *Reinhardt, Fortegnelse over Grönlands Krebsdyr*, p. 34 (1857); *Lütken, List of Crust. of Greenland in Arctic Manual*, p. 150 (1875).

Synidotea nodulosa, *Harger, Am. Journ. of Sci. & Arts*, (ser. 3) xv. p. 374 (1878); *id. Pr. U.S. Nat. Mus.* ii. p. 160 (1879); *id. Rep. Geol. Survey Canada*, p. 218 B (1878–79); *id. Isopoda in Rep. U.S. Fish Commission*, part vi. p. 351, pl. vi. figs. 33–35 (1880).

This species is closely allied to the foregoing, but is distinguished by its more convex and proportionately narrower body, and the form of the terminal segment, the distal end of which is obtusely pointed, not emarginate and bicuspid. The head is tuberculated above, the inequalities separated by deep depressions. The thoracic segments are convex or tuberculated above in the middle line, and very rugose on each side at some distance from the lateral margins. The postabdomen is longer than broad at base, and in the Museum specimen longer than the last four segments of the thorax, convex above, and rather contracted toward the distal extremity, with the lateral margins somewhat sinuated; the apex slightly produced and rounded and entire. Antennæ with the flagellum about 9-jointed. The terminal plates of the opercular valves are longer and more narrowed at the distal end (in the Museum example). Length rather more than $\frac{5}{6}$ inch (22 mm.), breadth nearly $\frac{1}{3}$ inch (8 mm.). Colour (in spirit) grey, with brownish markings.

This species, like *E. bicuspida*, has a wide circumpolar and boreal distribution; its range is from Siberia (Gulf of Yenissei) westward, probably throughout the Arctic seas, and southward on the east coast of North America to St. George's Banks, and on the west coast to British Columbia (Harger).

In the British-Museum collection there is only one specimen (a male) preserved in spirit, and believed to have come from the west coast of North America. In the Paris collection I have examined a considerable series of both sexes and different sizes from the sea of Mourman, near the Yenissei (Swedish Exped. of 1875–76).

In the Museum specimen and some of the Paris specimens the projecting postero-lateral angles of the first, partially coalescent, postabdominal segment form small lateral teeth.

Kröyer, in his description of this species, says, "*Epimera annulorum thoracicorum distincta, totum marginem annulorum lateralem obtegentia,*" on which account only am I doubtful of the specific identity of his species with *S. nodulosa* of Harger, who, however, is probably right in attributing Kröyer's description to an error of observation.

EDOTIA HIRTIPES.

Idotea hirtipes, *M.-Edwards, Hist. Nat. Cr.* iii. p. 134 (1840); *Krauss, Die südafrikan. Crust.* p. 61 (1843).

In this species the body is somewhat ovate, moderately convex, arcuated on the sides, evenly granulated above, with large inequalities on the sides of the thoracic segments at some distance from the lateral margins. Head with the anterior margin very slightly excavated, and with a semicircular curved impressed line posterior to its frontal margin, and another, nearly straight line near its posterior margin; its antero-lateral angles prominent and nearly right angles. The first three thoracic segments with an impressed curved line in the middle of the dorsal surface, and rounded at their postero-lateral angles; in none of the segments are these angles prolonged backward. Postabdomen short, rounded posteriorly, with a fissure on each side at its base, and with a small and shallow median emargination at its distal end. Eyes large. Antennules reaching nearly to the end of the penultimate joint of the antennæ, with their basal joints very small. Terminal joint of the peduncle of the antennæ longer than the preceding; flagellum with about 14–21 joints. Legs long, slender, hairy, and terminating in a long claw. Terminal plates of the opercular valves irregularly four-sided, being much narrowed at the distal end. Length of the largest specimen nearly 1 inch (25 mm.), breadth nearly $\frac{5}{12}$ inch (10 mm.).

The description (except as regards dimensions) is taken from Milne-Edwards's types.

There are in the British Museum several dried specimens from Simon's Bay, South Africa, collected on a sandy bottom in 4–7 fathoms; and others, without locality, collected by J. MacGillivray of H.M.S. 'Rattlesnake.'

In the Paris collection I have examined, besides four specimens from the Cape of Good Hope (types of M.-Edwards's description), others from the same locality (MM. Quoy and Gaimard), and several others, again, without particular locality.

EDOTIA HIRTIPES, var. LÆVIDORSALIS. (Plate III. figs. 1 & 2.)

Two males are in the collection of the Museum from Jatiyama Bay, Japan, obtained at a depth of $6\frac{1}{2}$ fathoms, lat. 39° 2′ N., long. 189° 50′ E., presented by Dr. J. Gwyn Jeffreys, and collected by Capt. H. C. St. John, R.N., that differ so slightly from *I. hirtipes* that I cannot regard them as specifically distinct. The body is quite smooth in the larger example, and very nearly so in the smaller (which is of larger size than any specimen of the typical *I. hirtipes* that I have seen), and in both is of a

decidedly narrower-oval form; the antero-lateral angles of the head are perhaps not so prominent and more rounded; the eyes are smaller. Length of the largest example about 1 inch 1 line (28 millim.); breadth about $\frac{5}{12}$ inch (10 millim.). In this specimen the flagellum of the antennæ is about 30-jointed, but in the smaller example (length $\frac{5}{6}$ inch, 21 millim.) only about 21-jointed.

§§ *Antennæ very small, with the flagellum rudimentary; postabdomen uniarticulate.* (Edotia.)

The species of this section may be distinguished by the following characters:—

a. *Dorsal surface of the body without a median line of tubercles.*

Lateral margins of the thoracic segments nearly straight and even; postero-lateral angles of the three posterior thoracic segments rounded; lateral teeth near the base of the postabdomen obsolete. 1. *E. triloba* (Say).

Lateral margins of the thoracic segments somewhat produced and angulated; postero-lateral angles of the three posterior segments rounded; subbasal lateral teeth of the postabdomen usually distinct. 2. *E. montosa* (Stimpson).

Lateral margins of the thoracic segments straight; postero-lateral angles of the three posterior segments acute; subbasal lateral teeth of the postabdomen distinct.

3. *E. magellanica* (Cunningham).

b. *Dorsal surface of the body with a median line of tubercles.*

Lateral margins of the thoracic segments nearly straight; postero-lateral angles of the three posterior segments subacute; subbasal lateral postabdominal teeth obsolete.

4. *E. tuberculata*, Guérin.

EDOTIA TRILOBA.

Idotea triloba, *Say, Journ. Acad. Nat. Sci. Philad.* i. p. 425 (1818); *M.-Edw. Hist. Nat. Cr.* iii. p. 134 (1840); *DeKay, Zool. of New York Fauna, Cr.* p. 43 (1844); *Leidy, Journ. Ac. Nat. Sci. Philad.* (ser. 2) iii. p. 150 (1855).

Jæra? triloba, *White, List Crust. Brit. Mus.* p. 97 (1847).

Epelys trilobus, *Smith, Rep. U.S. Fish Comm.* pt. i. p. 571, pl. vi. fig. 28 (1874); *Verrill, Amer. Journ. of Sci. and Arts,* (ser. 3) vii. p. 135 (1874); *id. Proc. Amer. Assoc.* p. 372 (1874); *id. Rep. U.S. Fish Comm.* pt. i. p. 370 (1874); *Harger, Pr. U.S. Nat. Mus.* ii. p. 160 (1879); *id. Rep. U.S. Fish Comm.* pt. vi. *Isopoda*, p. 358, pl. vii. figs. 42, 43 (1870).

This species, according to Harger, is of depressed-ovate form, and is marked by a depressed line on each side running from the posterior part of the head across the thoracic segments, nearer to their lateral margins than the median line (except perhaps on the last segment), thence to inclose a prominent hemispherical protuberance on the anterior part of the postabdomen; the body appears slightly roughened under a lens, or sometimes minutely hirsute. Head slightly dilated on the sides, with the antero-lateral angles produced, and with a pair of broad, low, triangular tubercles on its anterior part and a curved posterior depression. Thoracic segments with thick evident margins; first smallest, somewhat embracing the head, third and fourth largest, the last segment curving round the base of the postabdomen; all, according to the figure, have their antero- and postero-lateral angles rounded. Postabdomen shorter and broader than in *E. montosa*, with a rounded lobe near its base separated from the large posterior portion by a more or less evident incision; it is dorsally convex; lateral margins nearly even, and the distal is separated from the proximal portion by a broad and deep groove, which is continued to the margin, with only, at the most, traces of a tubercle on each side, the distal convexity being continued upon the obtusely-pointed apex. Eyes lateral and prominent. Antennules are longer than the head, and surpass the antennæ, with the basal joint but little enlarged. Antennæ shorter than the head, not surpassing the third antennulary joint; the joints increasing in length to the fourth, fifth as long as the fourth, but more slender; bearing the minute slender rudiment of a flagellum, which is setose at the tip. Legs slender, more or less hairy, with the slender reflexible dactylus almost acicular in some of the posterior pairs. Colour uniform, dull. Length about $\frac{1}{4}$ inch (6 millim.), breadth rather over $\frac{1}{12}$ inch (2·3 millim.).

This species ranges, according to Harger, along the eastern coast of the United States from Egg Harbour, New Jersey, to Quahog Bay, Maine.

There is in the Museum collection but a single small example of this species, preserved dry, from Egg Harbour, New Jersey (T. Say). A second specimen that formerly existed in the collection is now destroyed. I have therefore taken the description from Harger's Report.

The stylet on the second pair of postabdominal appendages in the male is a little less elongated than in the next species.

Edotia montosa.

Idotea montosa, *Stimpson, Marine Invert. Gd. Manan*, p. 40 (1853).
Epelys montosus, *Harger, Rep. U.S. Fish Commission*, pt. i. p. 571 (1874); *id. Pr. U.S. Nat. Mus.* ii. p. 161 (1879); *id. Rep. U.S. Fish Comm.* pt. vi. *Isopoda*, p. 359, pl. viii. figs. 44–47 (1880); *Verrill, Amer. Journ. of Sci. & Arts*, (ser. 3) vol. vii. p. 45 (1874); *id. Pr. Amer. Assoc.* p. 367 (1874); *id. Rep. U.S. Fish Comm.* pt. i. p. 270 (1874); *Smith & Harger, Tr. Conn. Acad.* iii. p. 3 (1874); *Whiteaves, Further Deep-sea Dredging G. St. Lawrence*, p. 15 "(1874)."

This species, according to Harger, closely resembles the foregoing, but is distinguished as follows:—The eyes are prominent; the antero-lateral angles of the head salient, and the tubercles on its upper surface more prominent than in *E. triloba*. The lateral margins of the thoracic segments, especially of the second, third, and fourth, are angulated and salient (in the middle, as the figure shows). Postabdomen more elongated than in the last species, its breadth being to its length as 5·5 to 10; the depression crossing it is partially interrupted at each side by a tubercle, which often projects, as seen from above, just behind the basal lobe, forming a shoulder to the large basal lobe. Stylet on the second pair of postabdominal appendages in the male attains the middle of the cilia. Colour as in the preceding, dull. Length nearly $\frac{5}{12}$ inch (10 millim.), breadth about $\frac{1}{6}$ inch (4 millim.).

It has been found as far north as Halifax and in the Bay of Fundy, and ranges southward to Long Island Sound.

Judging merely from the descriptions and figure I should much doubt if this species be really distinct from *E. triloba*; but having seen no specimens I cannot venture to unite the two forms.

Mr. Harger designates, under the name var. *hirsuta*, a few specimens collected in Whiting River, which are much more decidedly hirsute than is usual, both on the upper surface and the legs. In other respects they appear to be referable to *E. montosa*, although the posterior segments are rather less angulated at the lateral margin.

Edotia tuberculata. (Plate III. figs. 3–6.)

Edotia tuberculata, *Guérin-Méneville, Icon. Règne Anim., Cr.* p. 34 (1829–44); *Cunningham, Trans. Linn. Soc.* xxvii. p. 499 (1871).
Anisonotus falklandicus, *White, List Crust. Brit. Mus.* p. 97 (1847), descript. nullâ.

The body is ovate, convex, posteriorly acute, of very firm consistency. The head is tuberculate above, the elevations defined by deep grooves; its frontal margin is nearly straight, and is armed with two rounded tubercles in the middle, between the bases of the antennules; its antero-lateral lobes are rather prominent. The segments of the thorax have each a tubercle in the median dorsal line; a longitudinal depression on each side appears to mark the line of coalescence of the epimera; on the sides there is a less-marked but larger elevation, and the lateral margins are defined by a raised line; the postero-lateral angles of all the segments are but little prolonged backward, and are more or less rounded. The postabdomen does not equal in length the four posterior thoracic segments; it has a median elevation on the dorsal surface near its base, and three impressed lines appear to mark with more or less distinctness as many coalescent segments; beyond these the dorsal surface is nearly smooth, convex, with the lateral margins slightly sinuated and converging rapidly to the distal extremity, which is subacute. Eyes large, but with a small pigment-spot. Antennules rather widely separated at base, reaching beyond the end of the peduncle of the antennæ, with their basal joints very short and scarcely dilated. Antennæ with the peduncle slender; the last two joints nearly equal and each longer than either of the preceding; flagellum minute, 3-jointed, not half as long as the last peduncular joint, with its basal joint much longer than the two following, the last terminating in a pencil of rather long setæ. Legs slender, rather thinly clothed with hair, and with very long, slender, simple claws. The oblique raised line on the basal opercular plates extends over the posterior two thirds of their outer surface. The terminal plate is very narrow, triangulate, and acute at its distal end. Length of the largest example about $1\frac{1}{6}$ inch (30 millim.), breadth rather more than $\frac{5}{12}$ inch (11 millim.).

This species, as far as its range is at present known, is confined to the Straits of Magellan and the Falkland Islands.

There is in the Museum collection an example, preserved dry, from the Falkland Islands (W. E. Wright), designated by White *Anisonotus falklandicus*, and four males preserved in spirit from Gregory Bay, eastern Magellan Straits (Dr. R. O. Cunningham).

EDOTIA MAGELLANICA.

Edotia magellanica, *Cunningham, Trans. Linn. Soc.* xxvii. p. 499, pl. lix. fig. 6 (1871).

This apparently very distinct species differs from *E. tuberculata* as follows:—The body is relatively broader, less convex, the inequalities of the dorsal surface are less marked, and there is no median dorsal line of tubercles. The postero-lateral angles of the sixth and seventh thoracic segments are acute. The second coalesced postabdominal segment is partially distinct on the sides, where it is indicated by an acute tooth, and the terminal segment is not so much narrowed at its distal extremity. Length a little over $\frac{7}{12}$ inch (15 millim.), breadth about $\frac{3}{12}$ inch (7 millim.).

Five males, preserved in spirit, are in the collection, taken off Cape Espiritu Santo at the eastern entrance of the Straits of Magellan (Cunningham). This is the only recorded locality of this species.

§§§ *Flagellum of the antennæ obsolete; postabdomen biarticulate.* (Desmarestia, Epelys.)

A minute rudimentary flagellum *may* possibly exist in the single species of this section; the antennæ are represented as terminating in a pencil of *setæ*.

This section of the genus includes the single species

EDOTIA ? CHILENSIS.

Desmarestia chilensis, *Gay, Hist. de Chile, Zool.* iii. *Cr.* p. 287, pl. iv. fig. 1 (1849).

? Epelys annulatus, *Dana, Amer. Journ. of Sci. and Arts,* (ser. 2) vii. p. 427 (1849); *id. U.S. Expl. Exped., Cr.* ii. p. 706, pl. xlvi. fig. 8 (1853), young?

In this species, as described by Gay (from whose long generic and specific descriptions and figure the following is adapted), the body is subovate, rugose, anteriorly dilated and rounded, narrowed posteriorly; a lateral and longitudinal sulcus running along each side of the dorsal surface of the thorax gives, as in other species of the genus, a trilobated appearance to the body. The head is small, broader than long; its anterior border is biemarginate to receive the antennules; its median portion is very acute, bent downward, with a longitudinal sulcus very distinct in the middle. Thorax fusiform, slightly convex above. Length of the four anterior segments nearly equal, of the three posterior much

shorter; all have concave anterior and posterior margins, with the subtriangular lateral plates (coalescent epimera?) broad, thick, narrowed anteriorly, separated one from another, directed forward in the three first segments and backward in the three last. Postabdomen short, broad, very convex, with subparallel sides at base, narrowed posteriorly, with rounded apex, composed of two distinct segments—the first short, the second very large, scutiform, longer than broad. Eyes placed at the sides of the head, near the postero-lateral angles, small, black in the young, diminishing and becoming almost invisible in the adult. Antennules and antennæ short, thick, subequal, inserted in front of the head, composed of six joints, the last four larger than the basal, equal in length, but diminishing in diameter from the first to the last, which is conical and ends in a pencil of hairs; the second antennæ are inserted beneath the first and in the same vertical line. Legs little-elongated, robust, cylindrical, all terminating in a strong reflexible claw; the legs of the first pair much shorter than the rest, which are subequal. Colour yellow, variegated with grey. Length 2 lines (in the plate $\frac{1}{4}$ inch, nearly 7 millim.).

The author, in his description, mentions two large lateral plates of the postabdomen which are applied to and cover in large measure the ventral surface, by which, no doubt, the plates of the operculum are intended.

The *Epelys annulatus*, which I regard as probably the young of *Desmarestia chilensis*, is described by Dana as narrow, subelliptic. Head transverse, rather longer than first thoracic segment; frontal margin apiculate in the middle, a little concave on either side of the median prominence; antero-lateral angles rounded. Thoracic segments all short, prominent, transverse, nearly equal in length, the last four a little separated on each side, the three posterior sublunate (when viewed from above). Postabdomen 2-jointed; first segment very short, nearly obsolete, much narrower than the following; the second scutellate, triangular behind; the sides towards the base about parallel. Eyes minute, remote. Antennules a little shorter than the antennæ, 4-jointed, third joint a little longer than the others. Antennæ 5-jointed, not longer than the breadth of the head; joints short, the last three a little the longest. Legs subequal, similar in form, and terminating in a small claw; all rather short, the first pair the shortest. Length $\frac{1}{5}$ inch.

Chili, at Viña del Mar, three leagues north of Valparaiso (on the upper surface and embedded among the tentacles of an *Asterias*).

There is a slight pubescence and a few very short hairs at the extremity of the postabdomen; the opercular plates completely cover it below, and have hirsute margins. The antennæ are stoutish, and bear a few short hairs.

In the above citation I have combined in great measure Dana's generic and specific descriptions and subsequent remarks.

As in *E. chilensis*, the postabdomen is biarticulate, with the sides at base subparallel, head with a median frontal lobe, the first pair of legs the shortest.

Cleantis.

Cleantis, *Dana, Amer. Journ. of Sci. and Arts*, (ser. 2) viii. p. 427 (1849), xiv. p. 300 (1852); *id. U.S. Expl. Exped.* xiv. (*Cr.* 2) pp. 697, 707 (1853).

Erichsonia, *Dana, Amer. Journ. of Sci. and Arts*, (ser. 2) viii. p. 427 (1849), xiv. p. 300 (1852); *id. U.S. Expl. Exped.* xiv. (*Cr.* 2), pp. 697, 709 (1853); *Harger, Rep. U.S. Fish Comm.* pt. vi. *Isopoda*, p. 354 (1880).

Body more or less slender and elongated, narrow oblong or subelliptic, or very slender. Head transverse, with the eyes placed near to the lateral margins. Postabdomen with all the segments coalescent, or composed of two to five distinct segments. Antennules small. Antennæ well-developed, geniculate or non-geniculate, with the joints of the flagellum all consolidated and forming a single piece. Epimera distinct, small, some or all of them visible in a dorsal view. Legs slender, subsimilar; the penultimate joints of the three anterior pairs not dilated. Opercular valves nearly as in *Idotea*.

§ *Postabdomen with all its segments coalescent.* (Erichsonia.)

The species of this section may apparently be distinguished as follows:—

Elliptical, broadest in the middle: head with two distinct frontal tubercles; first and second thoracic segments triangulate on the sides. 1. *C. angulata* (Dana).

Suboblong: head with a bifid tubercle on its upper surface; thoracic segments laterally more or less angulated.

2. *C. filiformis* (Say).

Narrow-linear: head without a dorsal tubercle; thoracic segments with the lateral margins straight.

3. *C. attenuata* (Harger).

CLEANTIS ANGULATA.

Erichsonia angulata, *Dana, Amer. Journ. of Sci. and Arts,* (ser. 2) viii. p. 427 (1849); *id. U.S. Expl. Exp.* xiv. *Cr.* ii. p. 710, pl. xiv. fig. 10 (1853).

Is described by Dana as long elliptic; body a little convex, front excavated; head with two tubercles on the anterior margin and with two crenations on each side, in the posterior of which the eyes are situated. Head and thoracic segments angulated-transverse; four anterior segments of thorax with a tubercle at the middle, first and second triangular in outline on either side, third and fourth polygonal, the fourth the broadest and longest. Postabdomen uniarticulate, oblong, subscutellate, margin sinuous, broadest near apex, extremity triangulate obtuse. Eyes of moderate size. Antennules not one third the length of the antennæ. Antennæ longer than half the body, geniculated, 6-jointed; last three joints subequal, penultimate shortest, the last obtuse, clavate, and pubescent. Legs subequal, two posterior and two anterior shortest, basal joints stout and generally tuberculated. Epimera angular and visible from above, excepting the third and fourth pairs, the third is sometimes apparent in an upper view. Colour brown or yellowish brown; penultimate joint of legs with a black or brownish transverse band. Length $\frac{1}{2}$ inch.

Rio Janeiro. Among seaweed in the harbour; found with *Caprellæ*.

The above description is adapted from Dana's generic and specific descriptions and observations.

In the specimen observed by Dana the two frontal tubercles were situated a little to the left of the centre, the right antenna was a little larger than the left, and no tubercles were seen on the basal joints of the anterior legs.

CLEANTIS FILIFORMIS. (Plate III. figs. 7 & 8.)

Stenosoma filiformis, *Say, Journ. Acad. Nat. Sci. Philad.* i. p. 424 (1818); *M.-Edw. Hist. Nat. Cr.* iii. p. 134 (1840); *DeKay, Zool. New York Fauna,* vi. *Cr.* p. 44 (1844).

Idotea filiformis, *White, List Crust. Brit. Mus.* p. 95 (1847).

Erichsonia filiformis, *Harger, Rep. U.S. Fish Comm.* pt. i. p. 570, pl. vi. fig. 26 (1874); *id. Pr. U.S. Nat. Mus.* ii. p. 160 (1879); *id. Rep.*

U.S. Fish Comm. pt. vi. *Isopoda*, p. 355, pl. vii. figs. 38–41 (1880); *Verrill, Rep. U.S. Fish Comm.* pt. i. p. 316 (1874).

Body slender and elongated, strongly serrated in a lateral outline in a dorsal view, with nearly parallel sides and a median row of prominent tubercles, one large and bifid on the head, and one on each thoracic segment. Head quadrate. In the first two segments of the thorax the postero-lateral angles are salient and much elevated, in the third and fourth both antero-lateral and postero-lateral angles are salient but not elevated; in the last three segments only the antero-lateral angles are produced. Postabdomen about one third the length of the body, with a more or less evident tooth on each side near the base, and dilated and obtusely triangular at apex. Eyes prominent. The antennules reach beyond the middle of the third antennal segment. Antennæ more than half as long as the body, with the basal segment very short, next two or three times as long as the first, third to fifth nearly cylindrical, and the last or flagellar segment the longest and slightly clavate, bristly-hairy towards the apex. The epimera are visible from above in a dorsal view in front of the antero-lateral angles of the first and second segments, and behind the antero-lateral angles in the three posterior segments. The operculum is a little more vaulted than in *C. attenuata* and shorter, the basal plate is less than three times as long as broad, its terminal plate is triangular. Colour usually a dull neutral tint, without bright markings, but sometimes more or less variegated with brown or reddish, fading in alcohol. Length about $\frac{5}{12}$ inch (11 millim.), breadth rather under $\frac{1}{6}$ inch (3·4 millim.).

This species, Mr. Harger observes, was originally described from Great Egg Harbour, New Jersey. It is not uncommon along the shores of Long Island Sound, and as far east as Vineyard Sound, Massachusetts, but has not yet been found north of Cape Cod.

There is in the Museum collection a single dried specimen from Egg Harbour (J. Say).

* In a specimen in the Paris collection from Gloria (Brazil?) (MM. Castlenau & Deville) which I refer with much hesitation to this species, there is a single strong bilobated tubercle on the upper surface of the head; there is a distinct median dorsal tubercle only on the first thoracic segment, the three following being carinated rather than tuberculated; the angulated epimera

of the first and second thoracic segments are visible in a dorsal view below the lateral margins of the segments, which project laterally and upwards and are themselves triangulate. The terminal postabdominal segment is sinuated, scarcely toothed on the sides. The eyes are situate apparently on the postero-lateral lobes of the head; the antennules scarcely reach to the base of the antepenultimate joint of the antennæ, whose terminal joint is geniculate, *i. e.* bent outwardly at an angle with the preceding joint. Distal opercular valves triangulate, with the apex subacute. Length about $\frac{1}{3}$ inch ($8\frac{1}{2}$ millim.).

CLEANTIS ATTENUATA.

Erichsonia attenuata, *Harger, Rep. U.S. Fish Comm.* pt. i. p. 570, pl. vi. fig. 27 (1874), pt. vi. *Isopoda,* p. 356, pls. vi. & vii. figs. 36, 37 (1880); *id. Pr. U.S. Nat. Mus.* ii. p. 160 (1879); *Verrill, Rep. U.S. Fish Comm.* pt. i. p. 370 (1874).

This species, according to Mr. Harger, is at once distinguished from the preceding by its slender form and regular outline. The body is smooth throughout and about six times as long as broad, without prominent irregularities, and narrowly linear in outline. The thoracic segments increase in size to the third, which is equal to the fourth, and the last three are of a gradually decreasing size. The postabdomen presents only slight traces of a lateral tooth near its base, and is but little dilated towards the tip. The eyes are small and black. The antennules are short, slightly surpassing the second antennal joint. The antenna are stout and smoother than in the preceding species. The epimera are nowhere conspicuous, but may usually be seen from above, especially in the posterior segments. The operculum is longer than in the preceding species, the basal plate more than three times as long as broad, and the terminal plate elongated, triangular, and obtuse. Specimens preserved in spirit are of a light greyish yellow with minute black punctulations. Length rather more than $\frac{7}{12}$ inch (15 millim.), breadth a little over $\frac{1}{12}$ inch ($2\frac{1}{2}$ millim.).

It was abundant, according to Mr. Harger, at New Jersey, Great Egg Harbour, and has also been found at Noank, Connecticut, U. S. A.

I have seen no specimens.

§§ *Postabdomen consisting of more than one segment, distinct, and visible in a dorsal view.* (Cleantis.)

The species may be distinguished as follows:—

Postabdomen 2-jointed, its distal end subtriangulate.
1. *C. isopus*, Grube (ined.).

Postabdomen 3-jointed, its distal end subtruncated or slightly excavated. 2. *C. linearis*, Dana.

Postabdomen 5-jointed, its distal end deeply emarginate.
3. *C. granulosa*, Heller.

CLEANTIS ISOPUS. (Plate III. figs. 9–11.)

Cleantis isopus, *Grube* (*MS. in Coll. Brit. Mus.*).

The body has straight and subparallel sides, and is rather convex in the middle line; the head has a small transverse linear impression near its posterior margin; its anterior margin is somewhat excavated, and its antero-lateral angles nearly right angles. The anterior margin of the first segment of the body is concave; its antero-lateral angles are rounded and produced along the sides of the head almost as far as the eyes, which are situated in the middle of the lateral margins. The following segments of the body are all of nearly similar form and equal length, and are produced neither at the antero-lateral nor at the postero-lateral angles. The postabdomen is composed of two distinct segments, the first being very short; the terminal segment is scarcely longer than broad, convex above at base, with the sides at first nearly parallel, but near to the distal extremity suddenly convergent, so that the apex is very broadly and obtusely triangulate; it is marked on each side near the base with sutures indicative of two coalescent segments. The antennules are nearly as in *Idotea*; the antennæ rather more than half as long as the animal, with five joints visible in a dorsal view, the first two of which are short, the two next longer and subequal, and the last (which takes the place of the flagellum in *Idotea*) yet rather longer, and clothed with a few scattered short hairs. The epimera are almost linear, and in the first three segments extend along only half the length of the lateral margins; in the following segments they become successively longer. The legs are very slender; the fourth pair are, however, but little shorter than the preceding; the claws of all the legs are slender and slightly curved. The terminal opercular plates are three-sided, with the outer margins oblique and

slightly rounded to the distal extremity. Length of the largest example (a male) about $\frac{11}{12}$ inch (24 millim.).

Ojica, Goto Island, lat. 33° 12′ 30″ N., long. 129° 5′ E.: a male and two females were collected at low-water mark.

I am enabled to identify these specimens with the species designated (but, I believe, not yet described) as *Cleantis isopus* by Dr. Edward Grube, by comparison with two examples kindly presented to the British Museum by that gentleman; and I gladly avail myself of his specific name. Dr. Grube's specimens are from Chefoo.

CLEANTIS LINEARIS.

Cleantis linearis, *Dana, Amer. Journ. of Sci. and Arts,* (ser. 2) viii. p. 427 (1849); *id. U.S. Expl. Exp., Cr.* ii. p. 708, pl. xlvi. fig. 9 (1853).

In this species, according to Prof. Dana (from whose later work the description is taken) the body is very narrow-linear, and fully six times as long as wide. Head subtriangular behind and obtuse, set into the following segment; front truncate or a little excavate. Thoracic segments somewhat transverse; fourth, fifth, and sixth segments longest, the fourth nearly quadrate. Postabdomen 3-jointed; the first two segments very short, transverse; the third nearly twice as long as broad, having a suture near the base, the sides nearly parallel, postero-lateral angles truncate, apex truncate or slightly excavate. Eyes situated near the angles of the head. Antennules very small, not half the length of the antennæ, with their basal joints rather stout; third shortest, obconical; the fourth as long as the second and third together. Antennæ rather stout, shorter than half the body, 5- to 6-jointed, not geniculate; last four joints each oblong; last joint shorter than the preceding, elongate-ovate, pubescent. The epimera (in the figure) are not visible in a dorsal view. Legs compressed, with the last joint the longest; third pair twice as long as the first; fourth pair very much shorter than the third; the last four pairs gradually increase in length. Claw with a short spine beneath the apex. Colourless when obtained. Length 9 or 10 lines.

N. Patagonia, Rio Negro (from the stomach of a *Silurus*).

I have seen no specimens.

The *Idotea angustata* of Nicolet (Crust. in Gay's Chile, Zool. iii. p. 258, pl. iii. fig. 4, 1849) has the body narrow and elongated;

the four anterior segments of the thorax have the posterior margin narrower than the anterior, with the antero-lateral angles somewhat prolonged forward; the last three segments, on the contrary, have the anterior margin narrower than the posterior, and the postero-lateral angles enlarged and prolonged backward. Postabdomen rather more than one fourth the length of the animal, with three very distinct segments; the second segment with two rather obscure transverse sulci. Eyes red, occupying the antero-lateral angles of the head. Antennules approximated at base, and more slender than the antennæ, which are brownish or yellow, and reach only to the third thoracic segment. Legs yellowish. Colour brownish, mingled with pale yellow, and with a longitudinal median line, which occupies the whole length of the thorax. Length about 4 lines (in the plate $\frac{5}{12}$ inch, about 10 millim.).

In the figure the sides of the body are nearly parallel, and there are six distinct postabdominal segments, the first five being very short, and the last semicircularly rounded at its distal end. The antennæ are 5-jointed, without a distinct flagellum, the last joint similar to the preceding, on which account I place the species, provisionally at least, in *Cleantis*. As the name *Idotea angustata* has been preoccupied by Lucas, I would propose to designate this species, if distinct, *Cleantis Gayi*. It may be identical with *Cleantis linearis*, Dana, in which, however, the angles of the thoracic segments are less prominent, and the terminal segment truncated or even slightly excavated at its distal extremity. If, on the other hand, a distinct flagellum exist, the species must be placed in *Idotea*—*Idotea prismatica*.

CLEANTIS GRANULOSA.

Cleantis granulosa, *Heller, Verhandl. zool.-bot. Vereins, Wien*, xi. p. 497 (1861); *id. Cr. in Reise der Novara*, p. 132, pl. xii. fig. 2 (1865).

Body very narrow, broadest at the two anterior segments, narrowing very slightly from before backward, with the postabdomen as broad as the posterior margin of the thorax. Frontal margin of the head slightly emarginate in the middle; its posterior margin convex. Thoracic segments of equal length, broader than long, strongly convex, with the sides perpendicular. The antero-lateral angles of the first segment are only slightly prolonged forward. The postabdomen consists of five segments, of which the two anterior are shaped like the preceding thoracic

segments, being as broad as they, but much shorter, with the postero-lateral angles rather prominent; the two following segments are very narrow-transverse. The terminal segment is very long, very convex in the middle, abruptly deflexed toward the lateral and posterior margins, with the lateral margins parallel, directed somewhat inward toward the distal extremity; the posterior margin deeply excavated. The eyes are inserted behind the antero-lateral angles. Antennules very short, reaching to the end of the second antennal joint, with the terminal joint elongate-conical, and quite as long as the preceding cylindrical joint. The antennæ, when retracted, reach to the posterior margin of the fourth thoracic segment, and are 6-jointed; the joints decrease in thickness, but increase in length, from the base to the distal extremity; the basal joint is short and annular, the second and third joint with a dentiform process on its inner and upper distal margin and with a notch on the underside. Legs as in *C. linearis*. Epimera narrow, elongate-triangular, posteriorly acute. On the second, third, and fourth segments they appear shorter than, and occupy the anterior half of the lateral margins; on the three following segments they are anteriorly distinctly broader, occupy the whole of the lateral margins, and posteriorly even project somewhat beyond them. The whole surface of the body is finely granulated. Colour appears to be light brownish; legs and antennæ yellowish grey. Length a little under $\frac{1}{12}$ inch (22 millim.).

St. Paul.

As I have seen no specimens of this species, the description is taken from Prof. Heller's work.

The following are species which have been referred to the *Idoteidæ*, but belong to other families:—

Idotea psora (Linn.), Fabr.; *Idotea physodes* (Linn.), Fabr.; *Idotea albicornis*, Fabr.; *Idotea aquatica* (Linn.), Fabr.; *Idotea scopulorum* (Linn.), Fabr.; *Idotea penicillata*, Risso, on which M. Risso subsequently founded the genus *Oliska*.

The *Idotea euplectellæ*, Landois, Jahresb. Westf. prov. Ver. p. 42 (1878), inhabits *Euplectella aspergillum*, and is, according to Dr. Bertkau (Arch. f. Nat. Band xlvi. p. 272, 1880), very probably identical with *Cirolana multidigitata*. I have not seen Landois's description.

The species of the curious blind genus *Cæcidotea*, Packard, from

the Wyandotte and Mammoth Caves, which also inhabit wells in Orleans, Indiana, do not, as Dr. Packard at first supposed, belong to the *Idoteidæ*, but to the *Asellidæ*; and the so-called egg-sacs are uropoda (see Packard, 5th Annual Rep. of Peabody Acad. of Sciences, 1873, p. 94, and S. I. Smith, Rep. U.S. Fish Commission, pt. ii. p. 661, 1874). Specimens apparently belonging to *Cæcidotea stygia* are in the British Museum from the Kentucky Caves (G. Lewis, Esq.); but they are dried and in imperfect condition, and appear to have lost the uropoda.

The genus *Slabberina* of v. Beneden (Mém. Acad. Bruxelles, xxxiii. p. 88, 1861) was placed by this author in the *Idoteidæ*, but is without the characteristic operculum of the family; it is apparently synonymous with *Eurydice*, Leach.

The following species are too insufficiently characterized for me to assign to them their exact position in the system; probably some of them may even not belong to this family:—*Idotea* (*Cymothoa*) *americana*, Fabr.; *Idotea chelipes* (Fabr.), Latr.; *Idotea fasciata*, Latr.

Hope, Cat. Crust. Ital. p. 26 (1851), refers to two species of which I have seen no descriptions—*Stenosoma denticulatum*, Risso, from Nice, and *Leptosoma obtusicauda*, Costa, from Naples.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. Dorsal view of head and antennal region of *Glyptonotus entomon* (Linn.), showing the position of the dorsally situated eyes, and the form of the lateral cervical lobes, of the antennules, antennæ, &c. × 1½ diam.

2. Opercular valve, or modified uropod, of the same, viewed from the inner side, showing the position of the minute outer ramus, which is overlapped and concealed by the larger inner ramus. Nat. size.

3. Dorsal view of head of *Glyptonotus Sabini* (Kröyer), showing the structure of the antero-lateral cervical lobes, eyes, antennules, and antennæ, as in fig. 1. × 1½ diam.

4. Opercular valve (modified uropod) of the same, showing the form of the inner and outer rami, as in fig. 2. Nat. size.

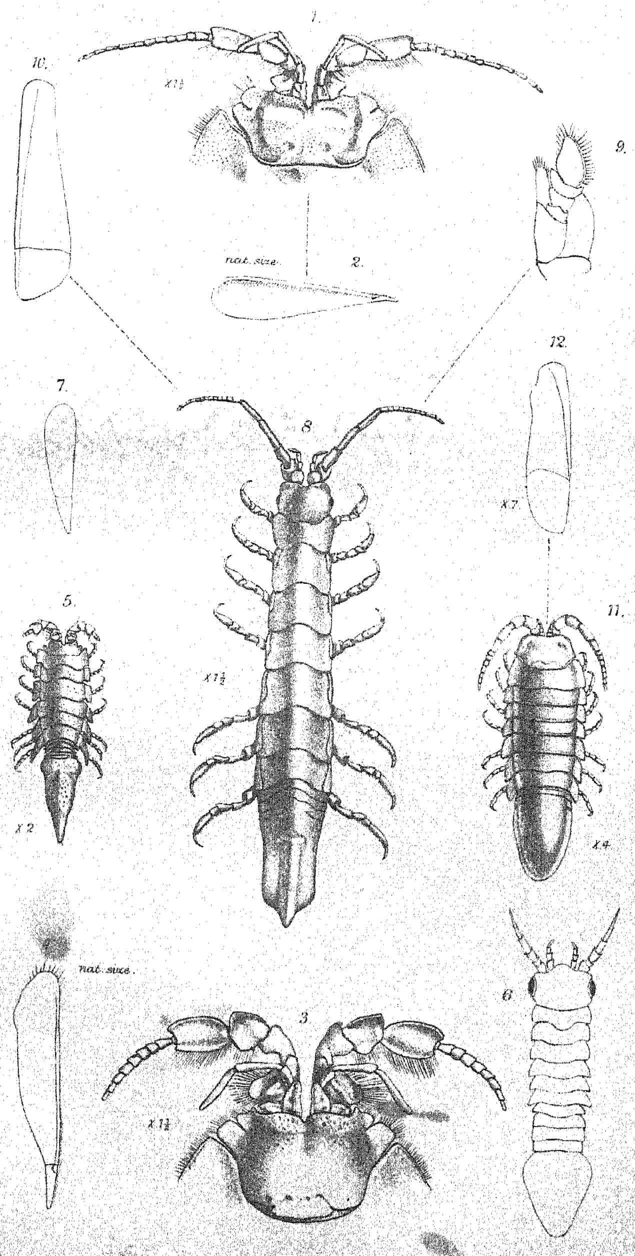
5. *Glyptonotus Sabini* (Kr.), young individual from Picton-Rock Glacier, × 2 diam.

6. *Idotea Whymperi*, n. sp., dorsal view, considerably magnified.

7. Outer view of one of the opercular valves of the same, considerably magnified.

8. *Idotea ochotensis*, Brandt, dorsal view of an adult specimen from Yedo Island, Japan, × 1½ diam.

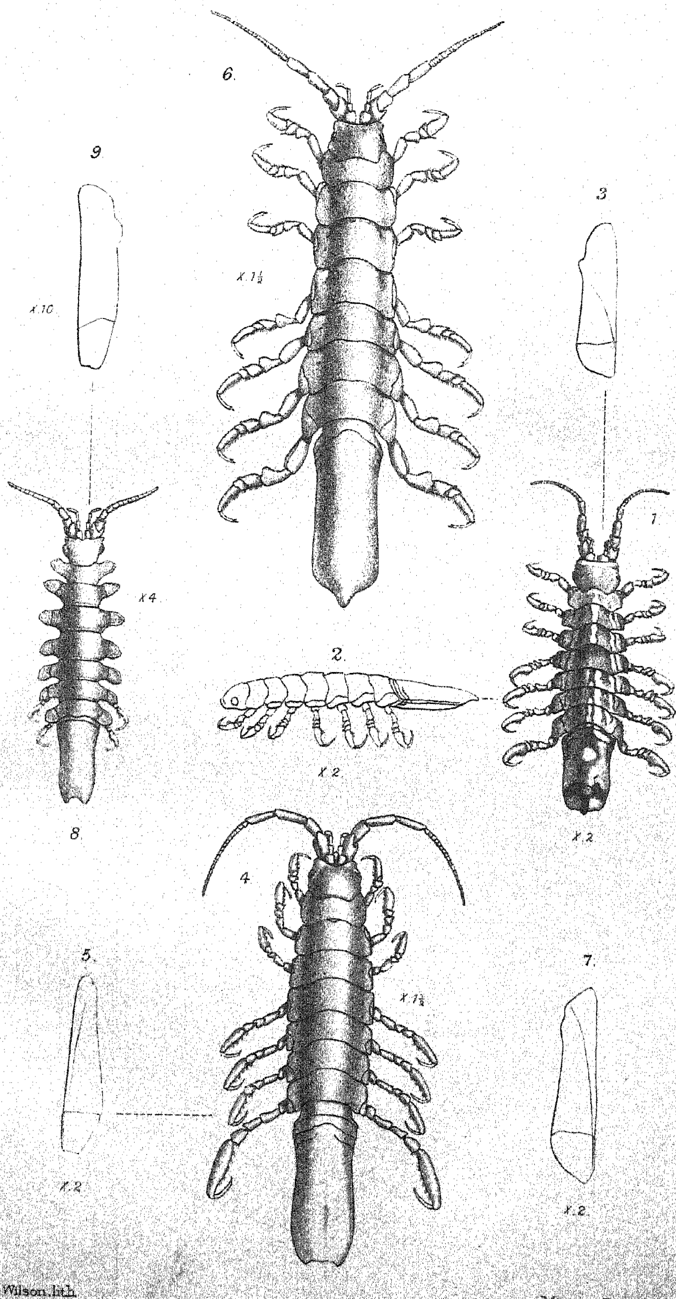
9. Maxillipede of the same, considerably magnified.



E. Wilson lith.

Mintern Bros imp.

SPECIES OF GLYPTONOTUS & IDOTEA.



E. Wilson lith.

SPECIES OF IDOTEA.

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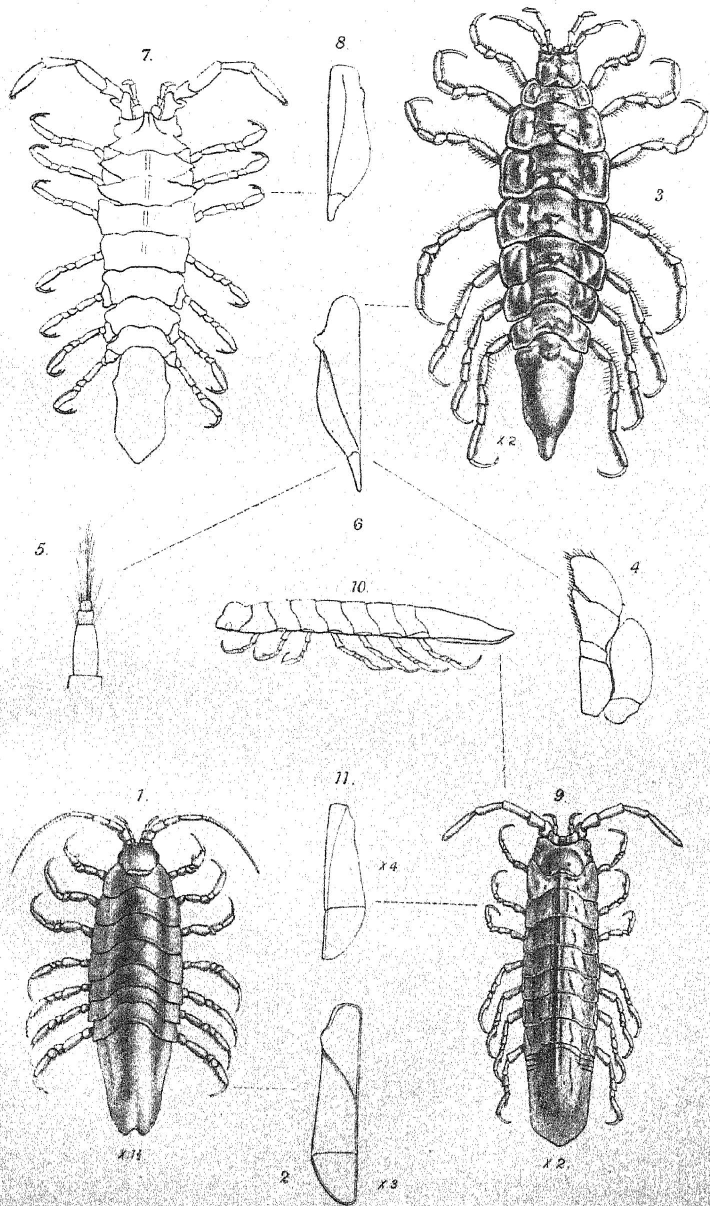


E. Wilson lith.

SPECIES & VAR. OF EDOTIA &

Mintern Bros imp.

Fig. 10. Outer view of opercular valve of the same, magnified.
11. *Idotea lacustris*, Thomson ?, from a specimen from Port Henry, Straits of Magellan, × 4 diam.
12. Opercular valve of the same, × 7 diam.

PLATE II.

Fig. 1. *Idotea Whitei*, Stimpson ?, dorsal view (from a specimen in the collection of the Paris Museum), × 2 diam.
2. Lateral view of the same, showing the form of the epimera, × 2 diam.
3. Opercular valve of the same, outer view, further magnified.
4. *Idotea indica*, M.-Edwards, dorsal view (from the type in the Paris collection), × 1½ diam.
5. Opercular valve of the same, × 2 diam.
6. *Idotea Peronii*, M.-Edwards, dorsal view (from a specimen from Flinder's Island), × 1½ diam.
7. Opercular valve of the same, outer view, × 2 diam.
8. *Idotea lobata*, White (ined.), dorsal view (from the unique type example in the collection of the British Museum), × 4 diam.
9. Opercular valve of the same, outer view, × 10 diam.

PLATE III.

Fig. 1. *Edotia hirtipes*, M.-Edw., var. *lævidorsalis*, n. var. (from a specimen from Jatiyama Bay, Japan), × 1½ diam.
2. Opercular valve of the same, outer view, × 3 diam.
3. *Edotia tuberculata*, Guérin-Méneville, dorsal view, × 2 diam.
4. Maxillipede of the same, greatly magnified.
5. Greatly magnified view of part of the antenna of the same, showing rudimentary flagellum.
6. Opercular valve of the same, outer view, considerably magnified.
7. *Cleantis* (*Erichsonia*) *filiformis* (Say) ?, dorsal view (from a specimen in the Paris collection), greatly magnified.
8. Opercular valve of the same, dorsal view, considerably magnified.
9. *Cleantis* (*Cleantis*) *isopus*, Grube (ined.), dorsal view (from a specimen in the British-Museum collection), × 2 diam.
10. Lateral view of the same, showing the form of the epimera, &c., × 2 diam.
11. Opercular valve of the same, × nearly 4 diam.

INDEX

TO THE

SUBFAMILIES, GENERA, SPECIES, AND SYNONYMS.

Synonyms are printed in *italics*.

ANNIVERSARY ADDRESS OF THE PRESIDENT,

Professor ALLMAN, M.D., LL.D., F.R.S.

Recent Progress in our Knowledge of the Development of the Ctenophora.

[Read May 24, 1881.]

IN accordance with my usual practice of making the Anniversary Address of the Linnean Society an exponent of recent progress in some department of zoological research, I have selected for the present occasion the additions which have of late years been made to our knowledge of the development of the Ctenophora.

In the summer of 1861 *Beroë ovata* made its appearance in great numbers in the Firth of Forth, and afforded me an opportunity of subjecting this beautiful Ctenophore to a careful anatomical and embryological study, and of making numerous drawings illustrative of its structure and development. Before, however, all the points I had wished to ascertain had been made out, the animals had disappeared from the coast; and in the hope of obtaining at a future period fresh subjects for examination, I contented myself with publishing an abstract without figures of the facts which I deemed most important, deferring the publication of the more detailed memoir to such time as I might be enabled to complete the unfinished observations. The opportunity, however, of doing so never occurred.

In this abstract * I called attention to the existence in the egg of an external structureless membrane, which is separated from the vitellus by a clear interval, while the vitellus itself previous to segmentation shows a differentiation into a denser peripheral layer and a central portion, which has the appearance of being composed of cells with clearer contents. The later observations of Chun go to show that this semblance to cells is only the expression of a vacuolated condition of the vitellus.

I pointed out that while the first stages of segmentation proceed in the usual way, the segmentation in its subsequent stages does not go on uniformly in all the previously formed cleavage-

* "Contributions to our Knowledge of the Structure and Development of the Beroidæ," Proc. Roy. Soc. Edinb. vol. iv. p. 519 (1862).

spheres, and that, in accordance with this, the segmenting ovum now presents spheres of unequal size. I showed that successive segmentation goes on with great activity in some of the spheres, while others continue unaffected by it, or present it with much less energy, and that the former become broken up into a multitude of cells, by which the latter become gradually enveloped, so that the ovum now presents two very distinct portions—a central one, composed of large spherical cells, and a peripheral one, of much smaller cells.

It was shown that on the completion of the peripheral layer a large lacunar cavity had become apparent among the cells in the centre of the ovum, and that soon after this a depression (the future mouth) takes place upon the surface of the embryo, and becomes deeper and deeper until the depression formed reaches the central lacuna, into which it finally opens. I overlooked, however, a still earlier stage, in which, according to Chun, the communication of the central cavity with the exterior takes place by means of an orifice, which shows itself at the pole opposite to that of the definitive mouth. To the embryo in this stage Chun assigns the significance of a *gastrula*, with its two embryonic leaflets, ectoderm and endoderm, its gastric cavity, and its mouth, which, however, has but a temporary existence, closing after a time, and being succeeded by the definitive mouth, which opens on the opposite pole.

I further showed that on the completion of the definitive mouth, the ocellus, with its capsule and the rudiments of the oval tentaculiferous disks (pole-plates), make their appearance on the aboral pole, and that the refractile corpuscles composing the ocellus may at this time be seen to be developed in the interior of special cells. The eight meridional rows of swimming-plates have by this time made their appearance, not at equal distances from one another, but in four pairs, extending from within a short distance of the aboral pole along the sides of the embryo, over about one fourth of the whole distance from pole to pole.

The next stage observed was characterized by the development of the vascular system. This commences by the differentiation of a portion of the large-celled tissue or endoderm, which constitutes the greater part of the embryo, into two somewhat pyriform masses, extending one on either side of the alimentary cavity, and which, simultaneously with their formation, become excavated by an extension of the central lacuna. They thus form two large

sacs appended to the central lacuna, and opening into it, and are to become the deep longitudinal or gastric vessels of the animal.

Nearly at the same time two other masses, exactly similar to the former, and also containing an extension of the central lacuna, are found opposite to one another on the two remaining sides of the alimentary cavity; so that this cavity is now surrounded by four sacs.

The two last-formed sacs now become divided, each into two, the halves diverging more and more widely from one another, and becoming more and more superficial, until we find them in contact with the peripheral or ectodermal layer of the embryo, each sac here corresponding to a pair of meridional swimming-bands and to the interval between them. The final dichotomy of the sacs now takes place, each of the last-mentioned dividing into two, from the peripheral towards the central side, leaving each half immediately under a meridional swimming-band; so that every swimming-band has now a sac to itself. The gradual conversion of the wide sac-like vessels into the narrow canals of the adult is easily understood. About this time the central cavity, into which the vessels whose development has been just described open, and which corresponds to the so-called funnel of the adult, has sent off two branches, which run towards the aboral pole, and form the canals which there open externally, one on each side of the sense-body.

Up to this point the embryo has been confined within the coverings of the egg; but in the stage next described the young *Beroë* was free. The meridional series of swimming-plates had extended further towards the mouth. The mouth was surrounded by a circular canal, into which the two deep longitudinal vessels (gastric vessels) had opened. The circular canal was probably developed from the oral extremities of these vessels as T-like branches, by whose inosculation the ring became completed. Four out of the eight meridional vessels (those, namely, which corresponded to the narrow sides of the stomach) had also opened into the circular canal; but the other four meridional vessels, though extending for some distance beyond the oral extremities of the series of swimming-plates to which they belonged, still terminated towards the mouth, each in a blind extremity. The eight meridional vessels had begun to send out their cæcal offsets, as yet few in number and simple. In a still further stage, the animal now

measuring about three fourths of an inch in length, all the meridional vessels had opened into the circular canal, while their cæcal offsets had become numerous and ramified. The series of swimming-plates, however, had not yet attained their entire length, while the generative organs had not made their appearance, and the processes which spring from the margin of the tentaculiferous disks were still nearly simple.

For reasons already mentioned this paper was unaccompanied by figures; and I have therefore probably no reason to complain that the points in which it anticipates the results of subsequent research have been either overlooked, as by Fol, who does not seem to have known of its existence, or to have been misunderstood, as by Kowalewsky, who, though aware of the existence of the paper, does not seem to have thought himself called upon to cite it. I am indebted to Alexander Agassiz first, and to Chun afterwards, for having amply recognized it.

Kowalewsky has studied the development of several species of Ctenophora, among which he has especially attended to that of *Eschscholtzia cordata*. His account of the structure of the egg in this Ctenophore agrees with my own in recognizing not only an external structureless membrane, but a differentiation of the vitellus into a peripheral and a central portion. The latter, however, he describes as composed of fat-globules; and he regards it as performing the function of a food-yolk (Nahrungsdotter), while the peripheral portion constitutes the formative yolk (Bildungsdotter), and affords the proper foundation for the embryo. With this view I am unable to agree. From my own observations, cited above, it follows that the whole mass of the ovum participates in the cleavage, and contributes directly to the formation of the embryo. Kowalewsky has seen the peripheral layer exhibit protoplasmic movements of contraction previously to the commencement of cleavage.

The remarkable and eminently characteristic feature in the egg-cleavage of the Ctenophora, which, as described above, results in an outer layer of minute cleavage-spheres, by which the central mass of larger, more slowly segmenting spheres becomes gradually enveloped, has also been well observed by Kowalewsky, who gives fuller details of the process than it was possible to embrace in the short abstract which I had myself published.

He describes the protoplasm of each of the large central spheres,

when these have been nearly enveloped by the layer of small peripheral spheres, as usually presenting towards its centre a more concentrated portion, in the form of a nucleus, from which filaments radiate towards the circumference of the sphere; but he does not regard this as representing a true cell-nucleus. He has noticed, however, a true cell-nucleus in each of the sphéres composing the enveloping layer.

He has observed the formation of the swimming-plates, which he describes as originating in series of cells, which at first project hemispherically from the surface of the embryo. Each cell carries on its projecting end a set of fine hairs, which ultimately become fused together, and form the vibrating swimming-plate. Will, as cited by Chun, appears to have already noticed the formation of the swimming-plates out of cilia thus fused together.

The newest point in Kowalewsky's memoir is probably his account of the migration of cells from the surrounding parts into the gelatinous substance which is to constitute the great mass of the body in the adult. This jelly shows itself at first as a very thin stratum between the peripheral layer of cells and the central mass; and he believes it to be formed at the cost of the large central cleavage-spheres. It is at first perfectly clear and structureless; but as it increases in volume some of the cells of the peripheral layer detach themselves, and wander into the jelly. This migration of the cells becomes more and more active. The migrating cells at first project from the peripheral layer into the jelly, into which they send off pseudopodia-like prolongations, and finally completely detach themselves, and move into the deeper parts of the jelly, where their offshoots freely anastomose with one another. Treated with carmine solution, the homogeneous part of the jelly becomes coloured, while the cells which had migrated into it remain unaffected by the pigment.

The observations of Kowalewsky afford further evidence in favour of the nervous character of the ganglion-like body which lies under the so-called ocellus, with its capsule; for he finds filaments passing from it to be distributed to each of the series of swimming-plates, every plate receiving a small branch from the filament common to the entire series. The origin of the otolites each in a cell, from which they escape and reach the interior of the capsule, has also been noticed by him.

Kowalewsky has also followed *Cestum veneris* through some of the early stages of its development; and he finds that the seg-

mentation of the vitellus presents the features characteristic of all the Ctenophora hitherto examined. He has traced its development up to the formation of the series of swimming-plates, which he describes as composed, like those in *Eschscholtzia*, of confluent hairs. At this period the young Cestum has a globular form; and the tentacles are of considerable length, and are quite similar to those of *Eucharis*.

The development of *Eucharis multicornis*, of *Cydippe hormophora*, and of *Pleurobrachia* has also been studied by him; and, so far as his observations have gone, he finds the development of these Ctenophora to take place quite on the type of that of *Eschscholtzia*.

Kowalewsky has further examined the development of *Beroë Forskalii*; and, though he has but a slight acquaintance with my own published researches on the development of *Beroë ovata*, he confirms, in their essential features, most of the results to which I had already arrived.

Some observations on the development of the Ctenophora have also been made by Fol, and published by him in the form of an inaugural dissertation *.

He describes the structure of the egg in *Euramphæa vexillifera*, Gegenb., his account of which agrees in all essential points with the previously published descriptions of the egg of other Ctenophores. He has observed also the phenomena of segmentation, and has seen the formation of both the large and the small segment-spheres, and the envelopment of the former by the latter. He appears to have seen the differentiation of the four endodermal masses which are to become the primordial trunks of the vascular system; but he does not seem to recognize their significance; while his account of the formation of the digestive cavity and funnel is but fragmentary, and, judging from the analogy of other species, is less in accordance with the actual course of the development than are the descriptions which had been previously published. His account of the proper embryonal development does not go beyond this stage; and the few further details which he gives us, apply to the young Ctenophore in a much more advanced stage of growth.

* Hermann Fol, 'Ein Beitrag zur Anatomie und Entwickelungsgeschichte einiger Rippenquallen,' Berlin, 1869.

Fol's dissertation, however, is mainly occupied with an account of the anatomy of adult forms; and the memoir is throughout illustrated by well-executed figures of development and structure.

The series of researches which, next in point of time, has contributed most to our knowledge of the development of the Ctenophora, we owe to Alexander Agassiz, who has given us a well-illustrated and valuable memoir on the embryology of *Idyia* (*Beroë*) and of *Pleurobrachia* *. In his account of the structure of the egg and of its development, he has confirmed in most points the results obtained by Kowalewsky, Fol, and myself, demonstrating by independent observation the remarkable process by which the first formed cleavage-spheres become gradually enveloped by a layer of smaller spheres resulting from a later division of those previously formed †.

He has studied in great detail this process, and describes the eight segment-spheres first formed as arranging themselves round

* Alexander Agassiz, "Embyology of the Ctenophora," Mem. of American Acad. of Arts and Science, vol. x. 1874.

† It may be a question how far the enveloping layer of small spheres represents a continuation of the proper yolk-cleavage, or is to be regarded as a post-morular formation. Agassiz, if I have correctly interpreted his remarks, would seem to maintain the latter view; and with this I am disposed to agree, though it is difficult to say where in the Ctenophora yolk-cleavage ends and a proper organ-formation begins, or what stage in the development of the egg we are to consider as corresponding to the proper mulberry-like condition of other ova. If we regard the proper yolk-cleavage as coinciding with the division of the egg-cell only so long as this continues uniform, we shall have a definite character to rest on, and the formation of the small peripheral spheres will then be a post-morular phenomenon resulting in the formation of the two germinal layers, ectoderm and endoderm. The mulberry-like condition would, it is true, in accordance with this view be completed at a much earlier stage, and be represented by a much smaller number of cells than perhaps in any other ascertained instance; but, notwithstanding this, the whole process could be brought more into accordance with what we already know of yolk-cleavage and its immediate results than would be possible if we were to regard the formation of the small peripheral spheres as a direct continuation of the proper yolk-cleavage.

The formation of the peripheral layer of small dark spheres by which the central large clear spheres become enveloped results in a condition which must be carefully distinguished from that of the unsegmented ovum, in which we have also a central clearer mass surrounded by a peripheral darker layer.

a vertical axis, while from that end of each which is turned towards the "actinal" pole of the ovum, or the pole where the mouth is ultimately to show itself, a small segment becomes constricted off. In the eight small spheres thus resulting, segmentation now sets in with great activity; these spheres multiply rapidly by division; and it is the layer of cells so formed which gradually extends towards the opposite pole of the egg over what remains of the eight large spheres, until these are finally completely enveloped by it. The large spheres also become multiplied by division, but much more slowly than the small ones.

The enveloping layer thus formed he calls the embryonal layer, and regards it as that from which the embryo is directly developed, while he regards the included spheres as performing only the functions of a food-yolk. This view, however, I find it as difficult to bring into harmony with my own observations cited above as I do the somewhat different views of Kowalewsky regarding a formative and a food-yolk *. It appeared to me certain that the mass of central spheres is the source from which the whole vascular system of *Beroë* is directly developed †. Indeed this, as has been since especially insisted on by Chun, is to become the endoderm, while the peripheral layer is the foundation of the ectoderm.

Agassiz has also seen the commencement of the swimming-plates in local accumulations of the cells which constitute the outer layer, and has recognized the formation of the mouth in a depression which takes place in a thickening of this layer at one pole, while the sense-body originates in a similar thickening at the opposite pole. He has further followed the formation of the digestive cavity, which shows itself as a deepening of the oral depression, accompanied by an inversion of the outer layer, the inbulging thus formed being described as gradually extending through the axis until it reaches the walls of the embryo at the opposite pole. He does not appear, however, sufficiently to insist on the fact that the tube formed by the inversion of the superficial layer always opens into a cavity which had been already formed in the centre of the embryo. I regard the independent formation of this central lacuna, and the opening into it of the digestive canal, as one of the most important morphological facts in the embryology of the Ctenophora.

* See above, p. 92.

† See above, p. 91.

The interesting observations of Kowalewsky regarding the formation of the gelatinous tissue have been confirmed by Agassiz, who has seen this tissue pervaded by cells, which have detached themselves from the outer walls, and migrated into the gelatinous mass.

The vessels are described as originating in four outbulgings of the digestive cavity, which rapidly push their way towards the oral pole. These tubes, as pointed out in the abstract cited above (see p. 91), really result from the transformation of the four great endodermal sacs, whose cavities are continued from the central cavity of the embryo, which ought to be distinguished from the true digestive cavity, being the part which is to become the so-called funnel of the adult.

Agassiz had already described * some of the more important stages in the post-embryonal development of *Pleurobrachia* (Cydipidæ) and of *Mertensia*, as well as in that of *Bolina*, which may be taken as a typical example of the lobate group of the Ctenophora, and had illustrated his memoir with many beautiful and highly expressive woodcuts. In the present memoir he has made a very careful study of the entire embryology of *Pleurobrachia*, and has shown that, setting aside the formation of the long retractile tentacles, which are absent in *Beroë*, it is in all points almost identical with that of *Beroë*. He has also shown that the changes undergone by the young *Mertensia* during its post-embryonal development, have an almost complete identity in all essential points with the post-embryonal changes of *Pleurobrachia*.

While the changes of *Beroë*, *Pleurobrachia*, and *Mertensia* during their post-embryonal development are not by any means striking, those presented by *Bolina* are on the contrary shown to be very great—a fact to which, in some important points, MacCrady had already, as cited by Agassiz, called attention. Up to the time when the young *Bolina* is ready to escape from the egg it can scarcely be distinguished from *Pleurobrachia* during a corresponding period, except in the fact that the compression of its body is in a plane at right angles to that of the compression in *Pleurobrachia*. It is after this that we find those well-marked changes of form, which show themselves in the acquisition of

* Alex. Agassiz, in Illustr. Catal. of Museum of Comp. Zool. Harvard College, 1865.

auricles and lobes, the complex windings and anastomoses in these of the vessels, and the almost complete disappearance of the tentacles, at first highly developed, like those of *Pleurobrachia*, changes which result in the very different and remarkable form of the adult *Bolina*, with its great lobe-like appendages and auricles.

By far the most elaborate and important treatise which has yet appeared on the Ctenophora is the recent great work of Chun on the 'Ctenophora of the Bay of Naples' *. This finely illustrated work is one of the many valuable contributions to zoology which we owe to the opportunity of research afforded by the Zoological Station at Naples. It treats of all the principal Ctenophoral groups, in their anatomical, embryological, and systematic relations.

His study of the development of *Eucharis multicornis* is made by Chun the basis of his general account of Ctenophoral embryology. To the two portions of the egg, the peripheral and the central, to which attention has been already called, he applies the terms "ectoplasm" and "endoplasm." The former he describes as a proper albumen-holding protoplasm, and the latter as a clearer vacuolated "cell-sap," and refers its apparent constitution out of spheres to its vacuolated condition.

The nucleus, which had escaped detection by the earlier observers, has been found by Chun imbedded in the ectoplasm. Kowalewsky†, though he failed at first to find it, recognized it afterwards in *Eschscholtzia* and *Eucharis*, while Hertwig‡ had seen it in *Callianira* and *Beroë*. Chun now finds it in all the Ctenophora examined by him.

The egg-cleavage is fully described; and in his account of its general character he confirms most of the observations made by Agassiz, Fol, Kowalewsky, and myself, while he adds some de-

* Fauna und Flora des Golfes von Neapel und der angrenzenden Meeres-Abschnitte. Herausgegeben von der zoologischen Station zu Neapel. I. Monographie. Ctenophora von Dr. Carl Chun. Leipzig, 1880.

† A. Kowalewsky, Investigations on the Development of the Cœlenterata, with 8 plates, in the Transactions of the Imperial Society of the Friends of Natural History, Anthropology, and Ethnography, Moscow 1873. This memoir is unfortunately published in the Russian language, and I am acquainted with it only through an abstract in Hoffmann and Schwalbe's 'Jahresberichte der Anatomie und Physiologie,' 1873.

‡ "Ueber den Bau der Ctenophoren," Jenaische Zeitsch. f. Naturwiss. Band xiv. p. 313 (1880).

tails regarding the later stages of this process. After the cleavage has advanced to the formation of four equal spheres lying in one plane, the next cleavage intersects the four spheres in an oblique direction, and divides each of them into a larger sphere, and a smaller one which lies obliquely upon it. The eight spheres, now no longer lying in the same plane, present a further difference in the fact that the main mass of the granular ectoplasm has passed over to the four small superjacent spheres, clothing them with a thick layer, and rendering their colour darker than that of the others—a condition which I had not noticed in *Beroë*, where, as Chun admits, it is by no means obvious.

As a general rule the eight segment-spheres thus formed divide almost simultaneously, each into two of dissimilar size. In this process nearly the whole of the ectoplasm is carried over into the eight smaller superjacent cells, while the eight large cells on which these lie consist chiefly of the endoplasm, being overlain only by a thin, scarcely visible layer of ectoplasm. In the later stages the endoplasm collects more and more about the nucleus of the large clear spheres, while their vacuoles flow together into a continuous cavity traversed by irregularly radiating and branching filaments from the central endoplasm.

After the cleavage has thus advanced so far that eight small cells lie on the eight larger ones, the first begin very suddenly and with great activity to divide, while the others remain quiescent. In *Lampetia* alone, which presents in its development many peculiarities, do we find the division of the large cells going on at the same rate with that of the small.

By the energetic division of the small cells the mass formed by the subjacent eight large cells becomes surrounded by a ring-like mantle, which gradually extends towards the poles. In the meantime division has been resumed in the subjacent cells, which from eight have become sixteen; and by the centrifugal separation of these cells from one another in the centre of the mass there is here formed a large vacuolar cavity which extends through the entire axis of the embryo. The enveloping cell-layer continuing to advance towards the poles, one of these becomes soon closed in, while the opposite pole remains as yet uncovered. About this time division is once more repeated in the sixteen large cells, without, however, presenting the regularity which had hitherto characterized this process.

In the stage at which the embryo has now arrived, with its two

layers of cells and its central cavity, and with one pole closed while the opposite pole remains open, Chun has recognized the morphological significance of a gastrula, and sees in the two layers of cells which form its walls the two primitive germinal layers, ectoderm and endoderm. He thus takes a view very different from that of Kowalewsky and A. Agassiz, who regard the large central cells as having the physiological value of a food-yolk. My own observations on the development of *Beroë*, as cited above, lead me to conclusions quite in accordance with the view taken by Chun.

The central cavity still communicates with the exterior by the gastrula-mouth, but becomes narrower by the pressure exerted by the ectoderm-cells, and is at last reduced to the condition of a narrow slit. In the meantime the ectoderm layer has been extending itself concentrically over the open pole, which it finally completely covers, and thus permanently closes the gastrula-mouth.

After the ectoderm has in this way completely grown over the endodermal cells, and both the poles have become closed, a thickening of the ectoderm may be noticed on each pole, caused on that where the gastrula-mouth had been situated by the cells here acquiring an elongated cylinder shape, while on the opposite pole the thickening is the result of the multiplication of the cells, which here become disposed in several layers. Out of the elongated ectoderm-cells which have shown themselves on the pole previously occupied by the gastrula-mouth, the central nervous system is to be differentiated, while in the thickened ectoderm of the opposite pole an inbulging may now be noticed; and we thus obtain the definitive mouth and the foundation of the digestive canal.

With this stage we have the first data for the orientation of the embryo; for we can now distinguish an oral pole from the opposite sense-pole, the axis passing through the two poles being the main axis of the Ctenophore.

Simultaneously with the accumulation of ectoderm-cells on the oral pole a similar accumulation may be seen in all Ctenophores, except the Beroidæ, on the right and left half of the embryo. The paired protuberances thus formed represent the foundation of the tentacle-apparatus.

Very early four symmetrically placed groups of ectoderm-cells become differentiated in a meridional direction from the rest by

enlarging and assuming a cylindrical form. Upon some of these cells may soon be seen a number of exceedingly fine cilia, which almost at their first appearance unite with one another, and form the embryo swimming-plate, as first observed by Will and afterwards by Kowalewsky. Each swimming-plate is thus the produce of a single cell.

Chun was the first to call attention to the fact that the entire ectoderm of the embryo is clothed with exceedingly minute vibratile cilia. Of these cilia eight linear series become more strongly developed simultaneously with the appearance of the swimming-plates, extend from the aboral end of every swimming-plate series towards the sense-pole, unite two by two, and finally end in the base of four strong sabre-shaped oscillating cilia.

When the ectodermal layer has closed over the gastrula-mouth, the cells composing it here multiply by division over a small polar area, and at the same time become elongated to about twice their original height. The sharply circumscribed ectoderm-region thus formed becomes somewhat rounded, sinks a little below the surface, and forms the central nervous system. Two semicircular groups of ectoderm-cells may now be seen, one on each side of the central nervous system. These soon acquire an elongated oval form, with the long axis in the plane of the stomach, and become the "pole plates." Surrounding the central nervous system may now be seen four groups of strong cilia. These increase in height, unite with one another so as to form a closed cilia-wreath round the nerve-mass; and finally the individual cilia become fused together and arch over the nerve-mass in the form of a closed capsule.

At an early period strongly refringent corpuscles may be noticed in many of the nerve-cells. These are finally expelled from their generating cells and become agglomerated into an otolite-heap, which lies in the interior of the nerve-capsule, where it is driven from place to place by the action of the cilia, which line the floor of the capsule, until it finally adheres to the curved ends of the four large sabre-shaped cilia already mentioned. The otolites are composed of phosphate of lime.

The central nervous system thus, of all organs of the Ctenophora, attains earliest its definitive form. Through its intimate relation to the swimming-plates it is among the most characteristic organs of the Ctenophora, and is found in all the species with great uniformity.

At the pole opposite to that where the gastrula-mouth had been situated, and which is now occupied by the site of the central nervous system, an inbulging of the ectoderm may be seen to take place in the line of the main axis. This gives us the origin of the definitive mouth and of the stomach, which continues to force its way deeper and deeper until it reaches a point a little beyond the middle of the body, and soon opens into the cavity which from a very early period had existed in the interior of the embryo, and which now becomes widened towards the sense-pole, and forms the foundation of the funnel. Even at this early period the lateral compression of both stomach and funnel may be seen, the two planes being placed at right angles to one another.

In the meantime the endoderm had become divided into two halves separated from one another by the plane of the stomach, and each of these again into two halves separated by the funnel-plane. Into each of the four endodermal masses thus differentiated an offset from the funnel extends, gradually advancing towards the mouth-pole, and soon widening into a considerable lumen. In these four sac-like masses of endoderm we have the first traces of the vascular system.

Between the stomach, funnel, endodermal sacs, and ectoderm the gelatinous tissue had already begun to be secreted as a clear layer, into which Chun had seen the migration of the richly ramifying cells from the ectoderm and stomach, to which Kowalewsky and Agassiz had already drawn attention. By the continued secretion of the jelly the embryo increases greatly in volume, and the endoderm-sacs become very distinct.

It is in the stage just described that, according to Chun, most embryos leave the egg, after which the differentiation of the definitive vascular apparatus out of the endoderm-sacs takes place. In *Beroë*, however, I have found development proceeding within the egg to a much more advanced stage.

Chun here makes an important generalization which legitimately follows from the course of the development now traced—namely, that two cavities destined to play different physiological parts in the life of the animal, one being devoted to the digestion of the nutriment and the other to its distribution, are derived respectively from two different germinal layers. The stomach owes its origin to the ectoderm, being formed by an in-

bulging of this membrane; while the funnel and the vessels which proceed from it are formed out of the large-celled endodermal tissue. This view, which is quite in accordance with my own observations (see above, p. 91), is inconsistent with the opinion that the large clear central cells serve only as a food-yolk.

The further, or post-embryonal development of the Ctenophora —that which takes place after their exit from the egg—does not offer the same uniformity as that found in the stages hitherto traced; and Chun describes it as it presents itself in different groups. He takes *Eucharis multicornis*, which had already afforded him a type for his description of the earlier stages of Ctenophoral development, as a type also of the post-embryonal development of the lobed Ctenophora.

When *Eucharis multicornis* leaves the egg it is of a pyriform figure and laterally compressed, so that the axis in the plane of the funnel exceeds in length the axis in the plane of the stomach. This is the characteristic condition of the *adult* state of another Ctenophoral genus, *Mertensia*, and is in striking contrast with the adult form of *Eucharis*, in which the axis in the stomach-plane is longer than that in the funnel-plane.

The tentacular apparatus lies concealed in small sheath-like depressions of the surface, one on either side. Each sheath contains two short rudimentary tentacles, of which the upper one rapidly grows and develops lateral branches, while the lower one remains rudimentary. The central nervous system is surrounded and overtopped by four roundish prominences of the gelatinous tissue. The ribs consist each of from four to five swimming-plates. The cells which had migrated into the jelly from the ectoderm and stomach-walls have already become elongated into true muscle-cells, and show themselves as fibres lying between the gastrovascular apparatus and the periphery.

Hitherto the vascular system has not shown an obvious distinction into funnel, central, and peripheral portions, and consists merely of two sacs which communicate with the central lacuna and send out short bulgings towards the ribs and the tentacular apparatus. The next changes, however, are essentially marked by the increased differentiation of the vascular system. Chun describes the two vessels which run along the broad side of the stomach towards the mouth (Magengefässe) as originating in ampuliform outbulgings of the two endodermal sacs; and though

he takes the same view of the origin of these vessels in *Beroë*, this does not correspond with the result of my own observations, from which I felt justified in concluding that in *Beroë* the two vessels in question originate in a direct transformation of two of the four sac-like masses which are differentiated out of the cells of the endoderm.

The larva increases in size; the stomach tapers from the wide mouth towards the laterally compressed funnel into which it opens. From the funnel the vessels are seen to be given off; and their regular dichotomous distribution, which is so characteristic of the Ctenophora, has begun to show itself. The four prominences which had raised themselves round the central nervous system have disappeared; and this lies henceforth free on the summit of the aboral pole.

The next development-stage of *Eucharis* is characterized by the appearance of the lobes, and by the unequal growth in length of the meridional vessels. The lobes show themselves as two lateral projections lying in the funnel-plane. At the same time a difference in the length of the meridional vessels becomes manifest, the four "subventral" vessels exceeding in length the four "subtentacular."

All the meridional vessels now grow rapidly towards the mouth-margin, extending themselves along the outer side of the lobes. When arrived at the oral region of the body, they begin to bend round on each side towards one another, and the subtentacular vessels anastomose with the subventral. The difference in length between the stomach-axis and the funnel-axis has now almost entirely disappeared, and the compressed *Mertensia*-like form of the larva has given place to a nearly spherical form.

To this stage of development would seem to succeed a remarkable form, which, though Chun did not trace it by continuous observation directly from the *Eucharis*-larva, having only obtained it in the towing-net, he believes, nevertheless, to be one of the forms which enter into the post-embryonal metamorphosis of *Eucharis*. The distribution of the vessels corresponds to that of the stage just described; but it is the only Ctenophore in which the main axis, or that which passes from the oral to the aboral pole, is much exceeded in length by the two lateral axes. This, along with the considerable development of the lobes, gives it a medusa-like aspect. Now, too, for the first time in the development-cycle of *Eucharis* do we find the plane of compression of

the animal corresponding to that of the adult; for we have the stomach-axis now exceeding in length the funnel-axis.

A further remarkable fact has been noted by Chun in this medusa-like larva, namely the total disappearance of the tentacle and the atrophy of the vessel which had supplied it; while at a later stage an entirely new tentacular apparatus becomes developed, and remains as the definitive tentacular apparatus of the *Eucharis*.

The central nervous system lies quite free on the aboral pole. Within the bell-like capsule may be seen the heap of otolites borne by the four large curved cilia, in which the lines of minute cilia which run along the course of the nerves terminate. The pole-plates have acquired their elliptical form; and on the sides of these the funnel-canals open with wide excretory orifices. The eight nerves run each to a swimming-plate series, extending through the entire length of the series, and communicating with every swimming-plate. At some distance from the last plates of the subtentacular ribs may be seen a number of minute plates, which are kept in connexion with the subtentacular ribs by a line of cilia. In these four rather isolated series of minute swimming-plates we see the foundation of the four so-called auricles, which, along with the lobes, are characteristic of the lobate section of the Ctenophora. The continuation of the nerve which runs along the rib may be also followed along the rudimentary auricles.

In the later stages the body becomes much elongated in the direction of the main axis, and the four gelatinous prominences become developed on the aboral pole round the central nervous system. At the same time the anastomosing meridional vessels have become thrown into complicated windings on the lobes, and the two stomach-vessels finally enter into the anastomosis.

A peculiarity of structure, which seems to have escaped the earlier observers, has been noticed by Chun in *Eucharis*. This consists in a blind sac, which, in the young animal, begins to show itself over the tentacle-basis in each body-half. It thence extends obliquely towards the stomach; and when arrived in the proximity of the stomach, it extends with the further growth of the animal in a direction chiefly towards the sense-pole and parallel to the stomach-walls, until in fully developed animals it reaches the funnel, or may even extend beyond it. Chun is unable to throw any light on the morphological significance or

physiological role of the blind sacs, no trace of which has been found in any of the other lobed Ctenophora*.

Among the most valuable observations of Chun are those which he has made on the development of *Cestum*, and which, with the exception of some fragmentary observations of Kowalewsky, afford almost the only information we possess regarding the embryology of this most interesting and highly aberrant type of Ctenophora. Chun has succeeded not only in observing the just hatched larva of *Cestum veneris*, but in following almost continuously its metamorphosis.

Cestum, when just hatched, presents the *Mertensia* type of form, and is almost identical in shape with the young *Eucharis*-larva, the difference between the two being found mainly in the tentacles, each of whose lateral filaments carry in the *Cestum*-larva a terminal knob of peculiar prehensile cells (Greifzellen). Each rib carries from four to five swimming-plates.

The *Mertensia*-like compression of the body is very obvious, the diameter in the plane of the funnel considerably exceeding that in the plane of the stomach; and this is rendered all the more significant when we bear in mind that in the adult not only is the compression of the body the reverse of this, but the length of the stomach-axis in the great band-shaped Venus's Girdle may be even a hundred times greater than that of the funnel-axis. Chun here remarks, with justice, that in few groups of the animal kingdom does the post-embryonal metamorphosis so strikingly recapitulate, even in the details of organization, the adult forms of more simply organized groups, as do the larval states of *Cestum* and the lobed Ctenophora recapitulate the configuration of the adult *Mertensiæ*.

The gastrovascular system shows, as yet, no obvious difference between central and peripheral vessel-trunks; but as the larva increases in size we find the vessels rapidly assuming their definitive distribution, and presenting a dichotomy so regular and normal that Chun has taken the *Cestum*-larva as an illustrative example of the typical form of the distribution of the vessels in the Ctenophora.

* We cannot avoid being here reminded of very similar sacs in certain Polyzoa, as well as of the segmental organs of the Annelida. It would be rash, however, to push the comparison further, and insist on a homological relation between the blind sacs of *Eucharis* and the segmental organs of the Annelida.

The tentacular apparatus, which is situated on a level with the funnel, gives origin not only to the main tentacle-stem with its lateral filaments, but also to a small independent stem, which Chun speaks of as a "reserve tentacle."

The condition of the ribs is very interesting in relation to the changes of form of the larva. By the time that the vascular system has nearly attained its characteristic dichotomous division, the four or five swimming-plates with which each rib had been hitherto provided have become reduced to a single one, to which a nerve runs from the central nervous system. In this change that plate which in each rib lies nearest to the sense-pole has become greatly increased in breadth, while those which follow it become atrophied and finally disappear.

The *Mertensia*-like flattening of the body in the plane of the stomach now gradually disappears, and the larva appears circular in transverse section. Soon, however, it presents again a slight flattening; but this is in the plane of the funnel, and with the growth of the larva becomes more and more decided, the length of the stomach-axis exceeding more and more that of the funnel-axis, until finally the long band-like form, characteristic of the adult Venus's Girdle, is attained.

With the band-like extension of the body the "subventral" meridional vessels are drawn out in the same direction, while the stomach-vessels send off each on the mouth-margin two branches at right angles to the main trunk, and the "subtentacular" vessels also diverge more and more to the right and left. At the same time the tentacular apparatus undergoes certain important changes. While the main tentacle still retains its original form, finger-like processes bud forth from the reserve tentacle: those at the proximal part of the tentacle remain fused together; but at the distal end they are differentiated into separate independent processes.

Though Chun has not succeeded in observing all the stages of the development of the tentacular apparatus, he regards it as almost certain that it is this reserve tentacle which is ultimately to become the definitive tentacle of *Cestum*.

Along the course of the subventral vessels new swimming-plates now make their appearance. Though at first arranged nearly vertically, this disposition rapidly yields to a horizontal one as the animal continues to assume its definitive band-like form. The form of the animal is now nearly that of a rectangle;

and the subventral vessels present a nearly horizontal direction in the greater part of their course, and then bend down in a vertical direction towards the oral edge of the rectangle; and as the swimming-plates are confined to the horizontal portion, the direction of each series is that which we meet with in the adult.

In the larva we can now plainly distinguish an aboral edge furnished with swimming-plates, an oral, and two lateral edges. On the latter the vertical ends of the subventral vessels run downwards towards the oral edge, while along this edge the horizontal branches of the stomach-vessels continue to extend themselves towards the angle formed by the meeting of the lateral and oral edges. Here they meet the ends of the subventral vessels, and anastomose with them. Each of the subtentacular vessels also extends in an oblique direction, from its origin under a subtentacular rib which never carries at this time more than a single swimming-plate, towards the same angle, where it meets the other vessels and soon enters into the anastomosis. The course of the vessels which characterizes the adult *Cestum* is thus in all its essential features established.

The body continues to elongate itself more and more in the form of a band; and with the consequent extension of the subventral vessels and their ribs numerous new swimming-plates are developed on the latter, while a few also show themselves on the subtentacular ribs, and the place of communication between the meridional vessels and the horizontal branches of the stomach-vessels moves towards the middle point of the lateral edges.

In the meantime the tentacle-apparatus has begun gradually to sink towards the mouth; and its sheath, appearing as a duplication of the dermal layer of the body, extends more and more over the tentacle, and runs on the margin into two furrows—the later tentacle-furrows. The original tentacle-stem with its accessory branches is still visible on the sheath; but at a later stage there is no longer any trace of it, and its place is taken by a tentacle-stem formed of numerous coalesced filaments, of whose origin from the reserve tentacle Chun believes there can be no doubt.

Chun also devotes some pages to a description of the post-embryonal development of the Beroidæ. Under this, however, he includes many stages which, in the examples examined by myself, were completed before the escape of the animal from the egg. The difference may depend on a difference in the species or

in external conditions, but is of no importance in the present inquiry.

In his account of the changes undergone by *Beroë* in the course of its development, Chun is not quite in accordance with some of the results at which my own observations led me to arrive. After the four endodermal sacs have been differentiated, their lacunæ, according to Chun, flow together two by two into a common cavity; and the place of the original four sacs is thus taken by two, from which all the vessels originate by a process of outbulging. My own observations, on the other hand (see above, p. 91), lead me to conclude that the two endodermal sacs which lie one on each of the broad sides of the compressed stomach, become directly transformed into the two deep-lying or gastric vessels, while the remaining two sacs, by lateral extension and dichotomous division, give origin to the rest of the vascular system.

In connexion with the embryology of the Ctenophora, Chun records an observation of considerable interest. He noticed, after a succession of very hot days, that the greater number of larvæ of *Eucharis multicornis* collected by the towing-net had their subventral meridional vessels changed into pouch-like swellings of a whitish colour. Many of these larvæ had plainly only just left the egg, while all were in a very early stage of development. In none of the more advanced larvæ could he find a trace of this peculiar condition of the vessels.

The microscope showed that the whitish pouches were filled with sexual products—that they represented, in fact, hermaphrodite glands, in which occurred, along with sperm-masses, eggs in various stages of development. Chun further proved that the eggs thus produced by the sexually mature larva of *Eucharis* were capable of passing through a development entirely similar to that of the eggs of the adult Ctenophore, from which these differed only in being about half their size; and he concludes that the young larva of *Eucharis* not only becomes sexually mature, but that it gives birth to a brood which again assumes the form of the larva. Several questions, however, connected with this phenomenon still remain unsolved; and the ultimate destiny of the sexually mature larva, and of the brood to which this gives birth, must await further observations for its determination.

Observations on Ants, Bees, and Wasps.—Part IX. By Sir John Lubbock, Bart., M.P., D.C.L., LL.D., F.R.S., President Linn. Soc.

[Read November 17, 1881.]

Colors of Flowers as an Attraction to Bees: Experiments and Considerations thereon.

The consideration of the causes which have led to the structure and coloring of flowers is one of the most fascinating parts of natural history. Most botanists are now agreed that insects, and especially bees, have played a very important part in the development of flowers: while in many plants, almost invariably with inconspicuous blossoms, the pollen is carried from flower to flower by the wind, in the case of almost all large and brightly colored flowers this is effected by the agency of insects. In such flowers the colors, scent, and honey serve to attract insects; while the size and form are arranged in such manner that the insects fertilize them with pollen brought from another plant.

Nevertheless these views have not escaped criticism. M. Bonnier, for instance, in an article on Nectaries, has attempted to show that they are in many respects untenable.

I do not propose on the present occasion to follow his general argument, but merely that portion of it relating to color. M. Bonnier, while not questioning the power of insects to distinguish colors, denies that they would be in any way attracted or guided by the colors of flowers. This he has attempted to demonstrate by experiment. With this view he proceeded as follows:—He took four cubes, 22 centim. by 12 (*i. e.* about 9 inches by $3\frac{1}{2}$), and colored red, green, yellow, and white, placing them 6 feet apart in a line parallel to and about 60 feet distant from the hives. He then placed on each an equal quantity of honey, and from minute to minute counted the number of bees on each cube. He found that the number of bees on each was approximately equal, and that the honey was removed from each in about twenty minutes. In the experiment he records the bees began to arrive directly the honey was arranged, and in ten minutes there were nearly a hundred bees on each cube. I presume, therefore, that the bees were previously accustomed to come to the spot in question, expecting to find honey.

I do not think, however, that any satisfactory result could be expected from this experiment. In the first place, after the first five minutes there were about thirty bees on each cube, and

in less than ten minutes nearly a hundred; the color therefore must have been almost covered up. The presence of so many bees would also attract their companions. Moreover, as the honey was all removed in less than twenty minutes, the bees were evidently working against time. They were like the passengers in an express train, turned hurriedly into a refreshment room; and we cannot expect that they would be much influenced by the coloring of the tablecloth. In fact, the experiment was too hurried and the test not delicate enough.

Then, again, he omitted blue, which I hope to show is the bees' favourite color; and his cubes were all colored. It is true that one was green; but any one may satisfy himself that a piece of green paper on grass is almost as conspicuous as any other color. To make his experiment complete, M. Bonnier should have placed beside the honey on the colored cubes, a similar supply without any accompaniment of color to render it conspicuous.

I could not, therefore, regard these experiments as at all conclusive. The following experiments seem to me a more fair test:—

I took slips of glass of the size generally used for slides for the microscope, viz. 3 inches by 1, and pasted on them slips of paper coloured respectively blue, green, orange, red, white, yellow. I then put them on a lawn, in a row, about a foot apart, and on each put a second slip of glass with a drop of honey. I also put with them a slip of plain glass with a similar drop of honey. I had previously trained a marked bee to come to the spot for honey. My plan then was, when the bee returned and had sipped about for a quarter of a minute, to remove the honey, when she flew to another slip. This then I took away, when she went to a third; and so on. In this way I induced her to visit all the drops successively. When she had returned to the nest, I transposed all the upper glasses with the honey, and also moved the colored glasses. Thus, as the drop of honey was changed each time, and also the position of the colored glasses, neither of these could influence the selection by the bee.

In recording the results I marked down successively the order in which the bee went to the different colored glasses. For instance, in the first journey from the nest, as recorded below, the bee lit first on the blue, which accordingly I marked 1; when disturbed from the blue, she flew about a little and then lit on the white; when the white was removed, she settled on the

green; and so on successively on the orange, yellow, plain, and red. I repeated the experiment a hundred times, using two different hives, and spreading the observations over some time, so as to experiment with different bees and under varied circumstances. Adding the numbers together, it of course follows that the preference shown for each colour is inversely as the number standing against it.

I now subjoin the numbers, giving the first day *in extenso*:—

Journeys.	Blue.	Green.	Plain glass.	Orange.	Red.	White.	Yellow.
1.	1	3	6	4	7	2	5
2.	5	4	7	6	1	2	3
3.	1	4	7	6	5	3	2
4.	2	4	6	7	5	1	3
5.	1	4	7	2	6	5	3
6.	1	2	3	6	5	4	7
7.	2	1	4	7	3	5	6
8.	3	4	6	2	7	5	1
9.	5	1	7	4	6	3	2
10.	1	6	7	5	3	2	4
11.	4	6	5	2	7	3	1
	26	39	65	51	55	35	37

In the next series of experiments the bees had been trained for three weeks to come to a particular spot on a large lawn, by placing from time to time honey on a piece of plain glass. This naturally gave the plain glass a great advantage; nevertheless, as will be seen, the blue still retained its preeminence. It seems hardly necessary to give the others *in extenso*. The following table shows the general result:—

Series.	No. of exp.	Blue.	Green.	Orange.	Plain.	Red.	White.	Yellow.
1st	11	26	39	51	65	55	35	37
2nd, May 30...	15	38	57	59	72	66	58	70
3rd, July 2...	16	44	76	82	73	53	53	67
4th, „ 4...	15	43	61	64	80	66	50	56
5th, „ 5...	10	36	47	39	40	40	36	42
6th, „ 6...	2	2	8	9	10	14	6	7
7th, „ 20...	11	33	39	50	47	49	41	49
8th, „ 23...	10	31	46	48	52	37	35	31
9th, „ 25...	10	22	54	38	52	33	35	46
	100	275	427	440	491	413	349	405

The precautions taken seem to me to have placed the colors on an equal footing; while the number of experiments appears sufficient to give a fair average. It will be observed also that the different series agree well among themselves. The difference between the numbers is certainly striking. Adding together 1, 2, 3, 4, 5, 6, and 7 we get 28 as the total number given by each journey; 100 journeys therefore give, as the table shows, a total of 2800, which divided by 7 would of course, if no preference were shown, give 400 for each color. The numbers given, however, are—for the blue only 275, for the white 349, yellow 405, red 413, green 427, orange 440, and plain glass as many as 491.

Another mode of testing the result is to take the percentage in which the bees went respectively to each color first, second, third, and so on. It will be observed, for instance, that out of a hundred rounds the bees took blue as one of the first three in 74 cases, and one of the last four only in 26 cases; while, on the contrary, they selected the plain as one of the first three only in 25 cases, and one of the last four in 75 cases.

	Blue.	Green.	Orange.	Plain.	Red.	White.	Yellow.
First......	31	10	11	5	14	19	9
Second ...	18	11	13	7	10	21	20
Third ...	25	12	8	13	16	13	13
Fourth ...	8	23	15	11	11	12	20
Fifth......	11	13	15	19	17	16	10
Sixth......	3	15	22	21	18	12	9
Seventh ..	4	16	16	24	14	7	19
	100	100	100	100	100	100	100

I may add that I was by no means prepared for this result. Müller, in his remarkable volume on Alpine Flowers, states that bees are much more attracted by yellow than by white *. In the same work he gives the following table:—

	In every 100 visits of insects there were			
Flowers.	Butterflies.	Bees.	Flies and Gnats.	Other insects.
3 yellowish-white species...	12·8	51·3	15·4	20·5
23 yellow ,, ...	47	27·5	28·1	7·2
16 red ,, ...	51·4	35·1	9·2	8·2
7 blue ,, ...	64·9	26·6	10·7	1·9

* 'Alpenblumen,' p. 487.

This table does not indeed show any absolute preference for one color rather than another. In the first place the number of species compared is very different in the case of the different colors; and in the second place, the results may of course be due to the taste, quantity, or accessibility of the honey (all of which we know exercise a great influence), rather than by the color of the flower. Still the table rather seems to indicate that bees preferred red, white, and yellow, to blue.

I may very likely be asked why it is that if blue is the favorite color of bees, and if bees have had so much to do with the origin of flowers, how is it that there are so few blue ones? I believe the explanation to be that all blue flowers have descended from ancestors in which the flowers were green, and that they have passed through stages of white or yellow, and generally red, before becoming blue. That all flowers were originally green and inconspicuous, as those of so many plants are still, has, I think, been shown by recent researches, especially those of Darwin, Müller, and Hildebrand.

But what are the considerations which seem to justify us in concluding that blue flowers were formerly yellow or white? Let us consider some of the orders in which blue flowers occur with others of different colors.

For instance, in the Ranunculaceæ *, those with simple open flowers, such as the buttercups and Thalictrums, are generally yellow or white. The blue Delphiniums and Aconites are highly specialized, abnormal forms, and doubtless, therefore, of more recent origin. Among the Caryophyllaceæ the red and purplish species are amongst those with highly specialized flowers, such as *Dianthus* and *Saponaria*, while the simple open flowers, which more nearly represent the ancestral type, such as *Stellaria*, *Cerastium*, &c. are yellow and white. I cannot, therefore, concur with Hildebrand in considering that red was the original color of the family.

Take, again, the Primulaceæ. The open-flowered, honeyless species, such as *Lysimachia* and *Trientalis*, are generally white or yellow; while red, purple, and blue occur principally in the highly specialized species with tubular flowers. The genus *Anagallis* here, however, certainly forms an exception.

Among the violets we find some yellow, some blue species; and

* I take most of the following facts from Müller's admirable work on Alpine Flowers.

Müller considers that the yellow is the original color. *Viola biflora*, a small, comparatively little specialized fly-flower, is yellow; while the large, long-spurred *V. calcarata*, specially adapted to Humble-bees, is blue. In *V. tricolor*, again, the smaller varieties are whitish-yellow; the larger, and more highly developed, blue. *Myosotis versicolor*, we know, is first yellow and then blue; and, according to Müller, one variety of *V. tricolor alpestris* is yellow when it first opens, and gradually becomes more and more blue. In this case the individual flower repeats the phases which in past times the ancestors have passed through.

The only other family I will mention is that of the Gentians. Here, also, while the well-known deep-blue species have long tubular flowers, specially adapted to bees and butterflies, the yellow *G. lutea* has a simple open flower with exposed honey.

Müller and Hildebrand * have also pointed out that the blue flowers, which, according to this view, are descended from white or yellow ancestors, passing through a red stage, frequently vary, as if the colors had not had time to fix themselves, and by atavism assume their original color. Thus *Aquilegia vulgaris*, *Ajuga genevensis*, *Polygala vulgaris*, *P. comosa*, *Salvia pratensis*, *Myosotis alpestris*, and other blue flowers are often reddish or white; *Viola calcarata* is normally blue, but occasionally yellow. On the other hand, flowers which are normally white or yellow rarely, I might almost say never, vary to blue. Moreover, though it is true that there are comparatively few blue flowers, still if we consider only those in which the honey is concealed, and which are, as we know, specially suited to, and frequented by bees and butterflies, we find a larger proportion. Thus of 150 flowers with concealed honey observed by Müller in the Swiss Alps †, 68 were white or yellow, 52 more or less red, and 30 blue or violet.

However this may be, it seems to me that the preceding experiments show conclusively that bees do prefer one color to another, and that blue is distinctly their favorite.

On Anergates.

The life-history of the genus *Anergates* is, in the words of Forel, an unsolved enigma. The species was discovered by Schenk, who found a small community consisting of males, females, and workers, which he naturally supposed to belong to one species. Mayr,

* 'Die Farben der Blüthen,' p. 26.

† 'Alpenblumen,' p. 492.

however, pointed out that the workers were in fact workers of *Tetramorium cæspitum*; and it would appear that while in *Strongylognathus* the workers are comparatively few, *Anergates* differs from all other ants in having no workers at all *. The males and females live with *Tetramorium cæspitum*, and are in several respects very peculiar: for instance, the male is wingless. One might consider it rather a case of parasitism than of slavery; but the difficulty is that in these mixed nests there are no males and females of *Tetramorium*. It seems quite clear that *Anergates* cannot procure its slaves, if such they are, by marauding expeditions like those of *Polyergus*—in the first place because they are too few, and secondly because they are too weak. The whole question is rendered still more difficult by the fact that neither Von Hagen† nor Forel found either larvæ or pupæ of *Tetramorium* in the mixed nests. The community consisted of males and females of *Anergates*, accompanied and tended by workers of *Tetramorium cæspitum*. The Anergates are absolutely dependent upon their slaves, and cannot even feed themselves. The whole problem is most puzzling and interesting. On the whole I would venture to suggest that the female *Anergates* makes her way into a nest of *Tetramorium*, and in some manner contrives to assassinate their queen. It must be admitted that even this hypothesis does not fully account for the facts. Still, I have shown that a nest of ants may continue even in captivity for five years without a queen. If, therefore, the female of *Anergates* could by violence or poison destroy the queen of the *Tetramoriums*, we should in the following year have a community composed in the manner described by Von Hagen and Forel. This would naturally not have suggested itself to them, because if the life of an ant had, as was formerly supposed, been confined to a single season, it would, of course, have been out of the question; but as we now know that the life of ants is so much more prolonged than had been supposed, it is at least not an impossibility.

At any rate the four genera of so-called slave-making ants offer us every gradation from lawless violence to contemptible parasitism. *Formica sanguinea*, which may be assumed to have compa-

* In *Tomognathus sublævis*, on the contrary, a Finland species, which lives in the nests of *Leptothorax muscorum* and *L. acervorum*, the workers only are known.

† Verh. des natur. Vereins der preuss. Rheinlande und Westphalens, 1867, p. 53.

ratively recently taken to slave-making, has not as yet been materially affected.

Polyergus, on the contrary, already illustrates the lowering tendency of slavery. They have lost their knowledge of art, their natural affection for their young, and even their instinct of feeding! They are, however, bold and powerful marauders.

In *Strongylognathus*, however, the enervating influence of slavery has gone further, and told even on the bodily strength. They are no longer able to capture their slaves in fair and open warfare. Still they retain a semblance of authority, and, when roused, will fight bravely, though in vain.

In *Anergates*, finally, we come to the last scene of this sad history. We may safely conclude that in distant times their ancestors lived, as so many ants do now, partly by hunting, partly on honey; that by degrees they became bold marauders, and gradually took to keeping slaves; that for a time they maintained their strength and agility, though losing by degrees their real independence, their arts, and even many of their instincts; that gradually even their bodily force dwindled away under the enervating influences to which they had subjected themselves, until they sank to their present degraded condition—weak in body and mind, few in numbers, and apparently nearly extinct,—the miserable representatives of far superior ancestors, maintaining a precarious existence as contemptible parasites of their former slaves.

It is conceivable that the *Tetramoriums* may have gradually become harder and stronger; the marauding expeditions would then become less and less frequent. If, then, we suppose that the females found it possible to establish themselves in nests of *Tetramorium*, the present state of things would almost inevitably be by degrees established.

Thus we may explain the remarkable condition of *Strongylognathus*, armed with weapons which it is too weak to use, and endowed with instincts which it cannot exercise.

Identification of Companions.

With reference to the interesting problem as to how ants recognize their companions, I have tried the following little experiment. It is of course well known, and has been abuudantly proved by my experiments, that although, if a strange ant is introduced into a community even of the same species, she is at once attacked, yet, on the other hand, if a few ants belonging to

different communities are placed together in a confined space, though at first a little shy, they gradually make friends. I thought therefore I would take a few specimens of *Formica fusca* from two different nests, which we will call nests A and B, place them together, and then, when they had lived together for some time, introduce the ants from nest A into nest B and *vice versâ*. Accordingly, having first ascertained by direct experiment, though I had myself no doubt on the point, that the ants in nest A would attack and expel an ant from nest B, and *vice versâ*, I took two ants from nest A on the 2nd December 1880, and put them in a small glass with two others from nest B.

Then, on the 23rd January, I put the two ants from nest A into nest B. One of them was at once attacked; about the other we could not be sure. Unluckily the two ants from nest B were killed by an accident.

On Feb. 24, 1881, I again took three ants from nest A and the same number from nest B, and put them together in a small glass. Then, on May 1, I put two ants from nest B into nest A. They were soon attacked very vigorously, and dragged out of the nest.

Thus, then, though these ants had lived amicably for some weeks with companions from another nest, they were not accepted as friends by the nest from which those companions were taken.

In consequence of a suggestion made by Mr. McCook, I took three specimens of *Lasius niger* and three of *Formica fusca*, and put them in water for an hour. After marking them, I put them back in the nest. The specimens of *L. niger* were put back at 11 A.M. They were quite amicably received, and the other ants began at once to lick off the paint with which they were marked. At 11.30 one was among the rest, evidently quite at home; the other I could not distinguish; but no ant was being attacked. At 12 the one was not quite cleaned; the other I could not distinguish. I looked from time to time during the afternoon, and certainly there was no fighting in the nest. The next morning I looked carefully; but there was no dead body, and I am satisfied they were amicably received.

The following morning at 7 A.M. I put in the three specimens of *F. fusca*. They were also evidently received as friends; and their companions began, as in the other case, to clean off the paint. At 7.30 they were quite at home among the others. 8, ditto. 9, ditto. 10, ditto. There could be no doubt about their recognition.

In my previous paper * I have recorded some experiments made

* Linn. Soc. Journ. vol. xiv. p. 610.

with pupæ in order to determine in what manner ants recognize their comrades.

For instance, I separated a nest of *Formica fusca* into two divisions in the spring before the season for laying eggs. Then in the autumn I took ants from one half (which I may call A) and put them into the other half (which I may call B). Thus, of course, there could be no question of individual recognition. Nevertheless, in nine cases such ants were received as friends. This season again, on the 10th April 1881, I divided a two-queened nest of *Formica*, leaving a queen in each half. At that time no eggs had yet been laid, and of course there were no larvæ or pupæ. In due course both queens laid eggs; and young ants were brought up in each half of the nest. I will call the two halves, as before, A and B. On the 15th August at 9 A.M. I put three of the young ants from A into B, and three from B into A. At 9.30 none are attacked. At 10, the same. At 10.30, the same; one is being cleaned. At 12, the same. At 2 P.M., the same. In fact they seemed quite at home with the other ants. The next morning I was unable to recognize them, the paint having been entirely removed. The ants were all peaceably together in the nest; and there were no dead ones either in the nest or in the outer box. It is evident, therefore, that they had been treated as friends.

August 17.—I put in three more from B into A at noon. At 12.30 they were with the other ants. At 1, the same. At 2, the same. At 3, the same. At 5 the same. The following morning I was still able to recognize them, though most of the paint had been removed. They also were evidently treated as part of the community.

Sept. 19.—Put in three more from A into B at 8.30 A.M. I looked at them at intervals of half an hour; but none of them were attacked. Next morning there was no ant outside the nest, nor had any been killed.

Oct. 10.—Put in three more at 7 A.M., and looked at intervals of an hour. They were not attacked, and evidently felt themselves among friends. The next morning I was still able to recognize two. There was no dead ant either in the nest or the outer box.

Lastly, on the 15th Oct. I put in four more at 7 A.M., and watched then all day at short intervals. They exhibited no sign of fear, and were never attacked. In fact, they made themselves quite at home, and were evidently, like the preceding, recog-

nized as friends. For the sake of comparison, at noon I put in a stranger. Her behaviour was in marked contrast. The preceding ants seemed quite at home, walked about peaceably among the other ants, and made no attempt to leave the nest. The stranger, on the contrary, ran uneasily about, started away from any ant she met, and made every effort to get out of the nest. After she had three times escaped, I let her go.

Thus, then, when a nest of *Formica fusca* is divided early in spring and when there are no young, the ants produced in each half were in twenty-eight cases all received as friends. In no case was there the slightest trace of enmity.

Peculiarities of Manner in Different Species of Ants.

In one of my previous memoirs* I have observed that the behaviour of *Lasius flavus* offered in some respects a surprising contrast to that of *Formica fusca*. In experimenting on the power of recognizing friends possessed by these species, I found that while specimens of *Lasius flavus* readily, and even of their own accord, entered other nests of the same species, *Formica fusca*, on the contrary, showed a marked reluctance to do so; and I had some difficulty in inducing them to do so. At that time, however, I did not ascertain what became of the specimens thus introduced into a strange community. I thought it would be worth while to determine this; so I took six ants from one of my nests of *Lasius flavus*, marked them, and introduced them into another nest of the same species. As in the preceding cases, they entered quite readily; but though they were not at first attacked, they were evidently recognized as strangers. The others examined them carefully; and at length they were all driven out of the nest. Their greater readiness to enter a strange nest may perhaps be accounted for by the fact that, as a subterranean species, their instinct always is to conceal themselves underground, whereas *F. fusca*, a hunting species, does not do so, except to enter its own nest.

Longevity of Ants.

In my previous paper I have called attention to the considerable age attained by my ants; and I may perhaps be permitted to repeat here, *mutatis mutandis*, a paragraph from my last communication with reference to my most aged specimens, most of

* Journ. Linn. Soc. vol. xiv. p. 611.

those mentioned last year being still alive. One of my nests of *Formica fusca* was brought from the woods in December 1874; it then contained two queens, both of which are now still alive. I am disposed to think that some of the workers now in the nest were among those originally captured, the mortality after the first few weeks having been but small. This, of course, I cannot prove. The queens, however, are certainly more than seven, and probably more than eight, years old. In the following nests, viz. another nest of *F. fusca*, which I brought in on the 6th June 1875, and one of *Lasius niger* on the 30th November 1875, there were no queens; and, as already mentioned, no workers have been produced. Those now living are therefore the original ones; and they must be between six and seven years old.

I had also some workers of *Lasius niger* which I began to observe on the 6th July 1875; the last of these died on June 15th, 1881. Lastly, some of *Formica cinerea* which I began to observe on the 29th November 1875, lived till the ants in this nest died off somewhat rapidly, the last on July 23, 1881. There were no queens in either of these nests; these workers therefore must have been more than 6 years old.

On the Sense of Color among some of the Lower Animals. By Sir John Lubbock, Bart., M.P., D.C.L., LL.D., F.R.S., President Linn. Soc.

[Read November 17, 1881.]

As I have already mentioned in a previous communication*, M. Paul Bert† has made some very interesting experiments on a small freshwater crustacean belonging to the genus *Daphnia*, from which he concludes that they perceive all the colors known to us, being, however, especially sensitive to the yellow and green, and that their limits of vision are the same as ours.

Nay, as I have stated (*loc. cit.*), he even goes further than this, and feels justified in concluding, from the experience of two species—Man and *Daphnia*—that the limits of vision would be the same in all cases.

* Journ. Linn. Soc. vol. xv. p. 376 (No. 87).

† Archiv. de Physiol. 1869, p. 547.

His words are:—

A. "Tous les animaux voient les rayons spectraux que nous voyons."

B. "Ils ne voient aucun de ceux que nous ne voyons pas."

C. "Dans l'étendue de la région visible, les différences entre les pouvoirs éclairants des différents rayons colorés sont les mêmes pour eux et pour nous."

He also adds:—"Puisque les limites de visibilité semblent être les mêmes pour les animaux et pour nous, ne trouvons-nous pas là une raison de plus pour supposer que le rôle des milieux de l'œil est tout à fait secondaire, et que la visibilité tient à l'impressionnabilité de l'appareil nerveux lui-même?"

These generalizations would seem to rest on a very narrow foundation. I have already attempted to show that the conclusion does not appear to hold good in the case of ants; and I determined therefore to make some experiments myself on Daphnias, the results of which are embodied in the present communication.

Prof. Dewar was kind enough again to arrange for me a spectrum, which, by means of a mirror, was thrown onto the floor. I then placed some Daphnias in a wooden trough 14 inches by 4 inches, and divided by cross partitions of glass into divisions, so that I could isolate the parts illuminated by the different colored rays. The two ends of the trough extended somewhat beyond the visible spectrum. I then placed fifty specimens of *Daphnia pulex* in the trough, removing the glass partitions so that they could circulate freely from one end of the trough to the other. Then, after scattering them equally through the water, I exposed them to the light for ten minutes, after which I inserted the glass partitions, and then counted the Daphnias in each division. The results were as follows:—

Number of Daphnias.

	Beyond the red.	In the red and yellow.	In the greenish yellow and green.	In the blue.	In the violet.	Beyond the violet.
Obs. 1. ...	0	20	28	2	0	0
„ 2. ...	1	21	25	3	0	0
„ 3. ...	2	21	24	3	0	0
„ 4. ...	1	19	29	1	0	0
„ 5. ...	0	20	27	3	0	0
	4	101	133	12	0	0

I may add that the blue and violet divisions were naturally longer than the red and green.

May 25.—Tried again the same arrangement, but separating the yellow, and giving the Daphnias the choice between red, yellow, green, blue, violet, and dark:—

	Dark.	Violet.	Blue.	Green.	Yellow.	Red.
Exp. 1.	0	0	3	39	5	3
„ 2.	0	1	2	37	7	3
„ 3.	0	0	4	31	10	5
„ 4.	0	1	5	30	8	6
„ 5.	0	1	4	33	6	6
	0	3	18	170	36	23

Of course it must be remembered that the yellow band is much narrower than the green. I reckoned as yellow a width of $\frac{3}{4}$ inch, and the width of the green 2 inches.

Again

	Dark.	Violet.	Blue.	Green.	Yellow.	Red.
Exp. 1.	0	0	4	30	6	10
„ 2.	0	1	3	25	8	13
„ 3.	0	0	2	24	9	15
„ 4.	1	0	3	25	8	13
„ 5.	0	1	2	24	7	16
	1	2	14	128	38	67

M. Paul Bert observes (*l. c.*) that in his experiments the Daphnias followed exactly the brilliance of the light. It will be observed, however, that in my experiments this was not the case—as there were more Daphnias in proportion, as well as absolutely in the green, although the yellow is the brightest portion of the spectrum.

I then so arranged the trough that the yellow fell in the middle of one of the divisions. The result was:—

Number of Daphnias.

	Ultra-red and lower red.	Upper edge of red, yellow, and lower green.	Greenish blue and blue.	Violet.	Ultra-violet.
Exp. 1.	8	38	4	0	0
„ 2.	9	36	5	0	0
„ 3.	8	39	3	0	0

May 18.—In order to test the limits of vision at the red end of the spectrum, I used the same arrangement as before, placing the trough so that the extreme division was in the ultra-red, and the second in the red. I then placed 60 Daphnias in the ultra-red. After five minutes' exposure I counted them. There were in the

	Red.	Ultra-red.
Exp. 1.	54	5
„ 2.	56	4

I now gave them four divisions—dark, red, ultra-red, and dark gain. The numbers were :—

	Dark.	Red.	Ultra-red.	Dark.
Exp. 1.	5	47	6	2
„ 2.	9	41	7	3

I then shut them off from all the colors excepting red, giving them only the option between red and ultra-red :—

	Red.	Ultra-red.
Exp. 1.	46	4
„ 2.	47	3
„ 3.	44	6

I then left them access to a division on the other side of the red, which, however, I darkened by interposing a piece of wood. This enabled me better to compare the ultra-red rays with a really dark space :—

	Dark.	Red.	Ultra-red.
Exp. 1.	4	43	3
„ 2.	3	45	2

Certainly, therefore, their limits of vision at the red end of the spectrum seen approximately to coincide with ours.

I then proceeded to examine their behaviour with reference to the other end of the spectrum.

I then shut them off from all the rays except the blue, violet, and ultra-violet. The result was as follows :—

Number of Daphnias.

	Ultra-violet.	Violet.	Blue.	Dark.
Exp. 1.	1	9	38	2
„ 2.	4	6	38	2
„ 3.	0	2	46	2

I afterwards gave them only the option of ultra-violet, violet, and darkness:—

	Ultra-violet.	Violet.	Dark.
Exp. 1.	8	48	4
„ 2.	6	48	6
„ 3.	12	47	1
„ 4.	15	42	3
„ 5.	4	53	3
	45	238	17

I then tried ultra-violet and dark. The width of the violet was 2 inches; and I divided the ultra-violet portion again into divisions each of 2 inches, which we may call ultra-violet, further ultra-violet, and still further ultra-violet. The results were:—

Number of Daphnias.

	Still further ultra-violet.	Further ultra-violet.	Ultra-violet.	Dark.
Exp. 1.	0	6	52	2
„ 2.	0	5	52	3
„ 3.	0	6	50	4
„ 4.	0	4	53	3
„ 5.	0	4	54	2
		286		14

May 18.—I again tried them with the ultra-violet rays, using three divisions—namely further ultra-violet, ultra-violet, and dark. The numbers were as follows, viz. under the

	Further ultra-violet.	Ultra-violet.	Dark.
Exp. 1.	6	50	4
„ 2.	3	55	2

To my eye there was no perceptible difference between the further ultra-violet and the ultra-violet portion; but slightly undiffused light reached the two extreme divisions. It may be asked why the still further ultra-violet division should have been entirely deserted, while in each case two or three Daphnias were in the darkened one. This, I doubt not, was due to the fact that the darkened division being next to the ultra-violet, one or two in each case straggled into it.

Not satisfied with this, I tried to test it in another way.

I placed over the ultra-violet division a glass cell containing a layer of sulphate of quinine about $\frac{3}{8}$ inch in depth, and over the further ultra-violet a similar cell with water. I had expected that the great majority would collect under the water-cell. The numbers, however, were :—

	Further ultra-violet, with cell containing water.	Ultra-violet, with cell containing sulphate of quinine.
Exp. 1.	8	50
„ 2.	4	54
„ 3.	11	49
„ 4.	4	56

The reason of this, however, seemed evident as soon as I tried the experiment, because, though the sulphate of quinine stops the ultra-violet rays, it turns them into blue light, and, to our eyes at least, actually increases the brilliance.

I then took a cell in which I placed a layer of 5-per-cent. solution of chromate of potash less than an eighth of an inch in depth, which, though almost colorless to our eyes, completely cut off the ultra-violet rays. I then turned my trough at right angles, so that I could cover one side of the ultra-violet portion of the spectrum with the chromate and leave the other exposed. The numbers were as follows :—

	Side of the ultra-violet covered with chromate of potash.	Side uncovered.	Dark.
Exp. 1.	5	55	0
	I now covered up the other side.		
„ 2.	3	57	0
	Again covered up the same side as at first.		
„ 3.	4	56	0
	Again covered up the other side.		
„ 4.	3	57	0

May 19.—Again the same arrangement. I reduced the chromate of potash to a mere film, which, however, still cut off the ultra-violet rays. I then placed it, as before, over one half of the ultra-violet portion of the spectrum; and over the other half I placed a similar cell containing water. Between each experiment I reversed the position of the two cells. The numbers were :—

	Under the film of chromate of potash.	Under the water.
Exp. 1.	8	52
„ 2.	4	56
„ 3.	10	50
„ 4.	7	53

Evidently even a film of chromate of potash exercises a very considerable influence; and indeed I doubt not that, if a longer time had been allowed, the difference would have been even greater.

It seems clear, therefore, that a film of a 5-per-cent. solution of chromate of potash only $\frac{1}{8}$ inch in thickness, which cuts off the ultra-violet rays, though absolutely transparent to our eyes, is by no means so to the Daphnias.

I then again returned to the sulphate of quinine; but instead of placing it close to the water, I suspended it at a height of 3 feet, so that the Daphnias were far less directly illuminated by the scattered light.

As in the preceding case, I placed by the side of it a similar cell containing water, and suspended them side by side over the water containing the Daphnias, and reversed the position after each experiment. The numbers were as follows:—

	Under the sulphate of quinine.	Under the water.
Exp. 1.	13	47
„ 2.	17	43
„ 3.	12	48
„ 4.	11	49
„ 5.	20	40
„ 6.	18	42
„ 7.	20	40
„ 8.	15	45

Although the contrast in this latter series is not so great, still it is unmistakable. It seems to me, therefore, though I differ with great reluctance from so eminent an authority as M. Paul Bert, that the limits of vision of Daphnias do not, at the violet end of the spectrum, coincide with ours, but that the Daphnia, like the ant, is affected by the ultra-violet rays.

Descriptions of some new Birds from the Solomon Islands and New Britain. By EDWARD P. RAMSAY, F.L.S., C.M.Z.S., &c., Curator of the Australian Museum, Sydney.

[Read November 3, 1881.]

1. CEYX SACERDOTIS, sp. nov.

Total length about 6 inches; bill from forehead 1·55, from gape 1·8.

Adult female.—A spot in front of the eye, the sides of the lower part of the throat, the chest, breast, sides, flanks, the margins of the shoulders, the under wing- and under tail-coverts, and the margins of the inner webs of the quills below, rich orange-buff; the throat and a spot on the side of the neck white; the centre of the abdomen whitish buff; the bases of all the feathers of the body above black; feathers of the interscapular region, back, rump, and upper tail-coverts of a rich glossy ultramarine; the head deep blue, with the tips of the feathers ultramarine; the tail-feathers black; quills black, their inner webs margined with orange-buff like the body; the cheeks like the head, very dark blue washed with cobalt, and separated from the white throat by a narrow streak of rich orange-buff. Legs and feet orange; bill orange, dark, almost brown along the culmen.

The young have the bill black with the tip white, but otherwise have the same coloration as the adult. The oblong spot behind the ear-coverts is white in both, but slightly tinged at the tips of the feathers with buff.

Hab. "Kabahadai," New Britain. From the Rev. George Brown's collection.

Remarks.—This fine species is allied to *Ceyx philippensis*; but has the centre of the abdomen white or nearly so, and a much greater extent of white on the throat. Dr. Otto Finsch, who has seen the specimens, is also of opinion that they are specifically distinct.

2. POMAREA (MONARCHA) UGIENSIS, sp. nov.

The whole of the plumage shining bluish black; the underside of the tail brownish black; the underside of the quills brownish black, of a lighter tint towards the base of the inner webs; the outer series of the under wing-coverts of the primaries brown tipped with black. Legs and feet black; bill blue-black, whitish on the tip and margins of the mandibles.

Total length about 7 inches; wing 3·5, tail 3·5, tarsus 0·8;

bill from forehead 0·95, from angle of the mouth 1·05, from nostril 0·6.

Sex female, adult. Both sexes are stated to be alike in plumage.

Hab. Island of "Ugi," Solomon Islands. From the Rev. George Brown's collection.

3. Calornis (Aplonis) feadensis, sp. nov.

Adult male.—The whole plumage above and below of a dull dark (almost blackish) sepia-brown. Bill blackish brown. Legs lead-colour.

Total length about 7 inches; wing 4·4, tail 2·5, tarsus 1; bill from forehead 0·95, from angle of the mouth 1·1, from nostril 0·5.

There is scarcely any gloss on the feathers, except perhaps in certain lights on the wings and tail.

Hab. Island of "Fead." From the Rev. George Brown's collection.

Remarks.—This species comes near to *Calornis fusca*, Gould, from Lord Howe's Island, from which species, however, it is quite distinct.

From the same island Mr. Brown obtained also specimens of *Monarcha inornata* of Lesson, which differs only in being of a deeper rufous on the abdomen, and having the ashy grey a little darker in colour.

I have also obtained from Mr. Brown some very beautiful Doves (*Ptilopus*)—one evidently *Ptilopus eugeniæ* of Gray, another with the head, neck, and chest light ashy and a faint lilac tint on the crown. These, with several other new species, have been forwarded to Canon Tristram by my friend Lieutenant Richards, R.N. I shall therefore not describe them.

In Mr. Brown's collection I noticed a unique and beautiful *Carpophaga*, of which Dr. Finsch has taken a description and kindly forwarded it to me to insert here. The following, then, is the description of this unique and beautiful bird, which I have dedicated to my friend.

4. Carpophaga Finschii, sp. nov.

Margin of the forehead, the sides of the head and neck, including the ear-coverts, chin, and throat of a delicate greyish vinaceous tint; a narrow ring of white round the eye; the upper part of the head light ashy grey; the nape and hind neck dark

grey; back and remainder of the upper surface of the body and wings dark golden green with coppery-red reflections in certain lights; quills black, the primaries margined with bluish metallic green on the outer webs, the primary-coverts tipped with golden green. The under surface, from the chest downwards, of a rich cinnamon-chestnut, becoming darker on the under tail-coverts; the tail-feathers of a rich steel-blue banded broadly with a band of ash-colour, the tips of the feathers being dark golden green. Bill black; cere reddish (dry skin); feet reddish purple; "irides red."

The size is about equal to that of *Carpophaga zoë* and *C. rufigaster* (Quoy et Gaim.).

5. BAZA GURNEYI, sp. nov.

Similar to *Baza Reinwardti* in many respects, but differs in having a paler head and neck, in having an almost pure white under surface, and in the bars being narrower, fewer, and of a darker tint. The shoulders are of a rich slate-colour of the same tint as the primaries; the breast and abdomen white, with a few very narrow cross bands of blackish slate; the margins of the shoulders and under wing-coverts white; a faint tinge of buff on the median under-coverts; the lower part of the abdomen and of the flanks and the under tail-coverts buff; tail ashy white below, ashy brown above, showing remains of two oblique blackish cross bands on its basal half, the first about the centre of the tail and extending over both webs, the apical third of the tail black. Bill black; legs and feet mealy brown; iris yellow.

Total length 15 to 16 inches; wing 12, tail 8, tarsus 1·3; bill (tip broken, but allowed for) 1·05, from gape 1·2.

Hab. "Ugi" (Rev. George Brown), and "Cape Pitt" (Cockerell), Solomon Islands.

Ugi is a small island about ten miles off "Gaudalcanar."

When I first notified *Baza Reinwardti* from the Solomon Islands, I was under the impression I had a veritable Solomon-Island bird before me. It now turns out that such was not the case; hence the mistake. There can be no doubt of the birds now under consideration both being from the Solomons. Dr. Finsch, who has examined my series, is of opinion that *Baza Gurneyi* is a good species. We have before us now specimens from New Britain, Port Moresby, Solomon Islands, and our own *Baza subcristata* from Australia: they are all probably varieties

of one and the same species; yet they show certain differences, which it is well to record under certain (specific) designations.

Note on Astur soloensis, *Ramsay* (*nec Lath.*).

Dr. Finsch, who has examined my specimen of *Astur soloensis* from Cape Pitt, is of opinion that it is not the true *A. soloensis*, Lath.

I therefore propose for the Solomon-Island bird the name of

6. Astur pulchellus, sp. nov.—Astur soloensis, *Ramsay* (*nec Lath.*), *P. L. S. of N. S. W.* iv. pt. 1, p. 66.

Hab. Solomon Islands.

7. Ptilotis eugeniæ, *Gray*.

After a careful comparison of many specimens, I have reluctantly come to the conclusion (which I have stated elsewhere) that the *Ptilopus* I referred to previously (P. L. S. of N. S. W. vol. iv. p. 73) as *Ptilopus viridis* is the female of *P. eugeniæ* (Gray). It is remarkable that the female of this species should be so brightly coloured on the breast. Moreover, young birds and so-called females, similar in plumage to the adults in all except having a purple breast, were obtained with the specimens I put down as *P. viridis* ♂.

The ornithology of the Solomon Islands is of so great interest that, an opportunity having offered, I have sent one of our taxidermists to the island of "Ugi," who, through the kindness of Capt. Bruce, R.N., will have opportunities of collecting and throwing some light on the subject, by carefully sexing the species. I hope by this means to clear up the doubt as to the sexes of my *Myiagra ferrocyanea* and *M. pallida*, and other birds of which we know little or nothing.

On the Homology of the Conario-hypophysial Tract, or the so-called Pineal and Pituitary Glands. By Professor Owen, C.B., F.R.S., F.L.S., &c.

[Read December 1, 1881.]

The structure and local relations of the pituitary and pineal glands, in Man, have received such close attention in anthropotomical works as to dispense with repetition. But, before entering upon the special aim of the present Paper, I feel bound to refer to

the latest contribution to the subject, that, viz., by Dr. Joseph Sapolini *, who has devoted a special treatise to one portion of the "tract" in question.

He more especially points out the continuation of the "third ventricle" of the brain by its tubular extension downward, called the "infundibulum," with the substance of the "pituitary gland," the texture, the blood-vessels, nerves, and osseous environment of which body in Man are minutely described and amply illustrated. The chief aim of these researches, however, is a teleological one; and the author arrives at the conclusion that the function of the so-called "gland" † is secretory, and that it relates to the supply of the intraventricular fluids of the brain.

Referring to the course from the third ventricle, by the infundibulum, to a cavity or reservoir in the hind lobe of the pituitary ‡, he concludes that the fluid secreted by the fore lobe accumulates in the "reservoir," and that, by vermicular movements of the gland, governed by the filaments of the sixth cerebral nerve, which he traces thereto, the fluid it secretes ascends, and passes by the tubular or infundibular continuation of the gland into the third, and thence into the fourth and other continuous vacuities or ventricles of the brain and myelon §.

"May we not then," he asks, "compare the pituitary gland to the liver, and its cavity to the gall-bladder?" ||.

* 'L'aire de la Selle Turcique,' 8vo, 1880.

† The term "pituitary" was originally applied thereto on the notion that it secreted the mucosity lubricating the nasal passages.

‡ "C'était mon aniline qui, depuis le troisième ventricule, était descendue à travers l'infundibulum et le canal de la tige pituitaire, jusqu'à la cavité de la glande. Ceci établit qu'il y a une parfaite communication entre la partie centrale du lobule du corps pituitaire et le troisième ventricule cérébral."—*Op. cit.* p. 63.

§ "A l'état physiologique il existe toujours dans les ventricules cérébraux un liquide incolore, inodore, insipide. Ce liquide non seulement peut, mais par moments doit, se mettre en mouvement; alors il dépasse dans sa course l'aquéduc de Sylvius, et suivant l'inclinaison du quatrième ventricule, il descend le long du canal rhachidien en passant par le trou du calamus scriptorius. Ce liquide, à l'état normal, augmente par instants dans les ventricules, et ce sera dans le troisième que se déversera le trop plein des autres."—*Op. cit.* p. 63.

|| "Le lobe antérieure de la glande sécréterait donc le liquide qui se rendrait et s'accumulerait dans le réservoir du lobe postérieur; il passerait ensuite par la valvule de la tige pituitaire qui peut et doit s'ouvrir; de là il montrait dans la tige elle-même qui est douée des mouvements vermiculaires, car elle est animée par des filets nerveux émanant du nerf de la sixième paire. Le corps pituitaire ne serait-il donc pas semblable, pour employer une comparaison hyperbolique, au foie qui sécrète la bile, et sa cavité à la vésicule biliaire qui est le réservoir de celle-ci?"—*Op. cit.* p. 64.

To this appeal, Dr. Sapolini, whose treatise issues from a Brussels press, may reasonably look for an affirmative response from the accomplished Professor of Liége. M. Ed. Van Beneden*, referring to the body in Tunicaries (Savigny's "tubercle," Hancock's and Ussow's "olfactory organ"), which is homologized by M. Julin† with the "pituitary gland" of Vertebrates, compares it to the kidney, and holds that by a communication with the "peribranchial cavity" of the Ascidian it discharges its urinary excretion therein.

The researches of which I proceed to communicate results have been conducted with a different aim, which has led me to trace both the pineal and pituitary bodies, their appendages and connections, or what I have termed the "conario-hypophysial tract," from Man downward, until, in *Amphioxus*, where the cerebral expansion of the myelencephalon is too feebly indicated, the homologue of any part of the tract in question has baffled my quest—unless the pore leading to the cavity in such expansion may be in relation thereto.

In the Mammalian series I have to observe that, in the lower and smaller members, as the brain loses in relative size and complexity, the pineal or conarial and pituitary or hypophysial bodies and connections show a relatively larger size, with a less parenchymatous and a less interrupted tubular structure than in the human brain. In the lower, if not lowest, forms of the feathered class I have noted a character of the basisphenoid which seemed to me to bear upon the present topic: it is a median longitudinal groove leading to a foramen opening into the seat of the pituitary body ‡.

But leaving here the class of Birds in the present summary, the proportions of the conario-hypophysial tract to the cerebral hemispheres in Reptiles become greater, and a vascular chord is continued upward from the hollow "pineal" part of the tract, beyond the cleft between the pros- and mesencephalon, to a con-

* Archives de Biologie, 8vo, 1881, tom. ii. fascicule ii. p. 230.

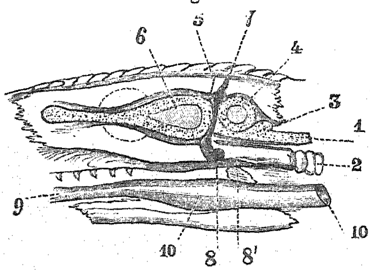
† Ibid. fascicule i. p. 59 *et seq.* (I may remark that, regarding the cylindroid shape as well as position of the neural centre in some Ascidians, I have viewed it as the homologue of the same part in *Amphioxus*, and the co-extensive body beneath as that of the notochord.)

‡ See 'Memoirs on the Wingless Birds of New Zealand,' 4to, 1878: *Dinornis elephantopus*, pl. lxxvi. fig. 4, 5; *D. crassus*, pl. lxxvii. fig. 3, 5; *D. ingens*, pl. lxxxii. fig. 3, 5; *D. gravis*, pl. lxxxi. fig. 4,—in which the foramen, not eustachian i unusually and significantly large.

tiguous opening in the bony cranial roof in a proportion of the class, which proportion is greater in the extinct members*. This "pineal" production perforates, as a rule, the parietal bone, but in some species the suture between that bone and the frontal, rarely the frontal bone itself, and then near the suture, always opposite the interval between the fore and mid brains. Beyond this hole, commonly called "foramen parietale," but which may preferably be termed "foramen pineale," the upward continuation of the conario-hypophysial tract or tube (fig. 1, 7, 8) is closed by the scalp or supracranial integument.

In the class of Fishes the relative magnitude and tubular character of this trans-cerebral tract is still more marked, examples of which I have elsewhere described and figured†. In the Skate

Fig. 1.



Section of cranium and brain of young *Iguana*, showing foramen parietale &c. —1. Neural axis. 2. Vertebral column. 3. Cerebellum. 4. Optic lobe. 5. Thalamencephalon. 6. Cerebrum. 7. Pineal body, 8. Pituitary body—conario-hypophysial tract (including "infundibulum" and "third ventricle"); 8′ indicates the "protopharynx" of the embryo. 9. Mouth. 10. Gullet.

* See 'Monograph on *Ichthyopterygia*,' Palæontographical Society's volume for 1881, 4to, p. 94, pl. xxiii. fig. 1, *f*; also "Descriptive and Illustrated Catalogue of the Fossil Reptilia of South Africa in the British Museum," showing the parietal or "pineal" foramen in the genera *Galesaurus*, *Petrophryne*, *Dicynodon*, *Ptychognathus*, *Oudenodon*, *Kistecephalus*, and *Procolophon*: in some of these genera the hole is unusually large.

† 'Anatomy of Vertebrates,' 8vo, vol. i. 1866, p. 277. "The third ventricle in Osseous Fishes is prolonged downward into the pedicle of the hypophysis or 'pituitary gland,' fig. 185, *p*, and upward into that of the conarium or 'pineal gland,' fig. 175, *w*. The true vasculo-membranous infundibuliform downward prolongation of the third ventricle exists in all Osseous Fishes. The 'infundibulum' is commonly short and thick, so that the hypophysis is almost sessile, as in the Cod; but in the *Lophius* the infundibulum is longer than the entire brain, and the hypophysis lies at the fore part of the cranial cavity far

(*Raia batis*) the extension of the pineal part of the tract in question reaches beyond the cartilaginous roof of the brain-case; in

Fig. 2.

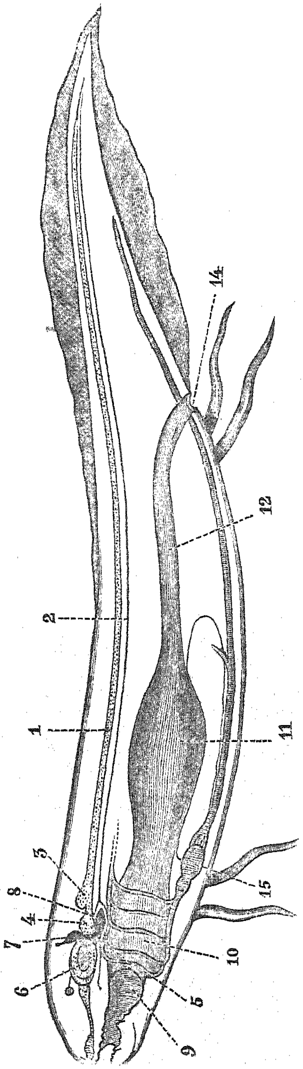
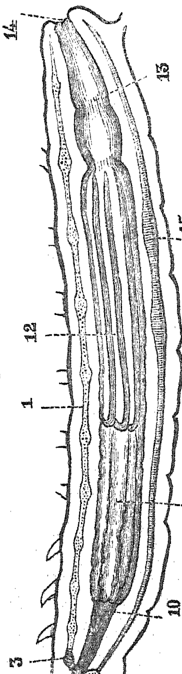


Fig. 2. *Protopterus*.—1. Neural axis. 2. Notochord. 3. Cerebellum. 4. Optic lobe. 5. Foremost branchial arch. 6. Cerebrum. 7. Pineal body. 8. Pituitary body (together, the conario-hypophysial tract). 9. Oral cavity. 10. Branchial cavity. 11. Stomach. 12. Intestine. 14. Vent. 15. Heart and chief blood-vessels.

Fig. 3.



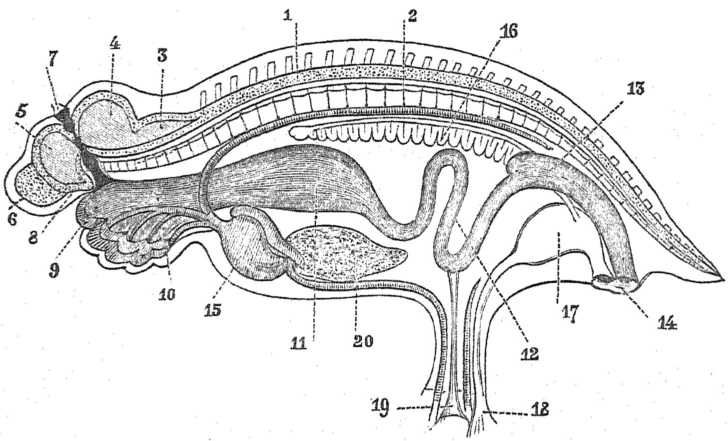
Larva of Sphinx.—1. Neural axis. 3. Hind-brain. 5. Connecting tracts or "crura," of 6, Fore brain. 7. Neural mouth, or neurostome. 7–10. Pharynx and gullet. 11. Stomach. 12. Hepatic intestine. 13. Rectum. 14. Vent. 15. Heart and chief blood-vessels.

in advance of the cerebral lobes (but in vertical parallel with the palate). In the Cod the hypophysis, fig. 185, *p*, is a subspherical mass, with an irregular surface almost half the size of the human 'pituitary gland,' and illustrating the vast proportional size of this constant appendage to the brain of Fishes" (p. 280).

the spiny Dogfish (*Acanthias*) its progress is there arrested. The direction of the pineal tube is forward as well as upward in all fishes. In that esculant form, *Protopterus* (fig. 2), the first-found member of which was referred to the Amphibia under the name "*Lepidosiren*," the width and length of the "infundibulum" continued from the flattened discoid body, 8, cut off from the bucco-branchial cavity, 9, 10, by a thin lamelliform extension of the basis cranii, is continued by a proportionally wide "third ventricle" into the base of a conical "conarium," 7, as large as the cerebellum itself, from the apex of which conarium a vascular membranous tubule is continued upward and forward through a gristly part of the cranium to the scalp*.

The homology thus suggested of the conario-hypophysial tract in Vertebrates with a vascular canal traversing a corresponding part of the brain in Invertebrates (fig. 3, 7, 10), called for further evidence; and such has been amply yielded by Embryology.

Fig. 4.



Mammalian embryo.—1. Neural axis. 2. Vertebral axis. 3. Cerebellar vesicle and medulla oblongata = epencephalon. 4. Optic vesicle = mesencephalon. 5. Vesicle of third ventricle. 6. Cerebral vesicle = prosencephalon. 7. Pineal portion, 8. Pituitary or infundibular portion, of the conario-hypophysial tract. 9–10. Bucco-branchial cavity. 11. Stomach. 12. Small intestine. 13. Large intestine. 14. Vent. 15. Heart and chief blood-vessels. 16. Primordial kidney. 17. Urinary bladder. 18. Pedicle of allantois. 19. Pedicle of umbilical vesicle. 20. Liver.

* *Tom. cit.* p. 282, fig. 186.

In the Vertebrate embyro (fig. 4) the myelencephalon, 1–6, first appears as a longitudinal channel of the ectoblast, opening "neurad;" and soon, by upward or neural extension and convergence of its side-walls, it is converted by their confluence into a tube.

Passing over the histological steps in the formation of the grey and white matters and the reduction thereby of the canal to the minute central one of the adult myelon, what here concerns my argument is the progressive forward extension of the cord, with corresponding expansions into the beginnings of the "hind brain," or epencephalon (fig. 4, 3), of the mid brain or mesencephalon (*ib.* 4), and of a large vesicle (*ib.* 5), dividing the latter from the fore brain, or "prosencephalon" (*ib.* 6). All these expansions, as shown in the diagram (fig. 4), are hollow; but the relative size of the cavity, of the so-called "third ventricle" (5), is now the largest of the embryonal cerebral vesicles; and this disproportion moreover coincides with an incomplete phase of the Vertebrate alimentary canal; and, what is more to the present contention, the huge homologue of the "third ventricle" extends into two productions of its wall, one downward (8) to a canal, "infundibulum," now communicating with the anterior end of the digestive cavity (9); the other upward (7), to the "thalamencephalon" *.

I next pass to the phenomena of the development of the digestive cavity. What subsequently becomes an alimentary canal, begins like the myelon, as a groove, parallel therewith, but opening in the opposite direction, or "hæmad," and there communicating with the vitellicle. It is developed most conspicuously or in greatest proportion from the hypoblast. As the alimentary rudiment extends beyond the yolk-sac, forward and backward, it becomes tubular, but as yet is closed at both ends. It absorbs, or receives, nutriment from the yolk-bag, which recedes as it diminishes and becomes excluded from the abdomen by completion of

* In his exemplary monograph 'On the Development of Elasmobranch Fishes,' 8vo, 1878, Mr. Balfour writes:—"During stage L the infundibulum becomes much produced, and forms a wide sack in contact with the pituitary body, and its cavity communicates with that of the third ventricle by an elongated slit-like aperture" (p. 176). . . . . "During the same stage the pineal gland grows into a sack-like body" (p. 177). . . . . At a later stage (P)—"The pineal sack has also become greatly elongated, and its somewhat dilated extremity is situated between the cerebral rudiment and the external skin. It opens into the hind end of the third ventricle, and its posterior wall is continuous with the front wall of the mid-brain" (p. 177).

the walls of that cavity, save where the primitive yolk-canal, fig. 4, 19, passes on to the shrunk vitellicle, now shut out as an appendage, ultimately to be absorbed or cast off at birth. Here, however, we have a primordial "mouth" and "gullet," or parts holding functionally, though transitorily, those relations to the digestive sac. The persistent indication of such course of the embryonal food is called "umbilicus:" it points to one inlet of food which has made way for another; and that other will make way for a third. As well devote pains and speculation to the "function" of the navel as to analogous remnants of a later communication with the alimentary canal, doomed likewise to obliteration with concomitant solidification of parts.

In low radiate forms of life, *Medusa* e. g., the vitelline entry, or "protostome," is permanent; a "deutostome" may, in like manner, appear as another step in the rising scale which is not parted with.

But to return to our Vertebrate grade. The alimentary tube, parallel with the myelonal one, communicates or anastomoses therewith at both ends; a common canal thus results, but of which the hæmal portion will be modified to give sustenance to the body, the neural portion to the mind. In the course of differentiation the caudal intercommunion is first abolished. The anterior end of the alimentary tube (fig. 4, 11), extending forward, comes into close contact and continuity with the canal which may be described as commencing below at the "infundibulum," and as continuing upward by the third ventricle to the base or origin of the pineal production of the thalamencephalon, which production, perforating, as in the embryo Iguana, the soft lamellar basis of the cranial roof-bones, is only arrested in its aim to form a mouth, or "deutostome," at the vertex, by failing to overcome the resistance of the superincumbent epithelial layer—such resistance being encouraged by the processes now on foot to establish an external communication, elsewhere, with the fore part of the alimentary canal.

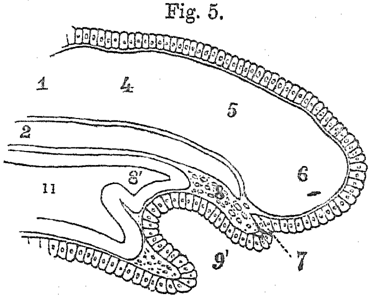
In *Amphioxus* and its earlier or humbler relatives the Ascidians, a mouth, or oral passage, is formed, which opens behind into a vascular expansion from which the alimentary canal is continued. This branchial sac is on the under or hæmal side of the fore part of the neural axis, issuing, in the lower division of Vertebrates, in the perfection of a water-breathing apparatus, and manifesting in the embryos of the higher half of the subkingdom unequi-

vocal traces of a branchial organization, as shown in fig. 4, 10. But, although this organization subsides, the hæmal mouth, or "tritostome," is in them retained.

Having noted, briefly, the indications of an earlier or neural mouth-way, or œsophagus, in the embryo of Vertebrates next above the brainless *Amphioxus*, I may premise that, with the appearance, in Invertebrates, of a brain including both supra- (fig. 3, 6) and sub- (*ib.* 3) œsophageal masses or ganglions—better termed, respectively, "hæmœsophageal" and "neurœsophageal" —the canal dividing them is developed as a "gullet" (*ib.* 10), and its outward opening is established as a "mouth" (*ib.* 7) or "deutostome."

In cerebral Vertebrates, also, there appears a beginning, or attempt so to speak, of a canal or tubular extension directed brainward. This developmental phenomenon is contemporaneous with the enlargements of the fore end of the myelencephalon, as seen in the embryos of Cyclostomous fishes*. In fig. 5 these enlargements are represented by the figures 4, 5, 6, the latter now pushing beyond the notochord, 2. Toward the middle one of these extends the tubular production (8′) from the digestive sac (11). In the line opposite to the production (8′) is an infolding of the ectoblast (7), which Scott indicates as that of the nasal cavity and hypophysis ("gemeinsame Einbuchtung für Nasengrube und Hypophysis," *loc. cit.* p. 171, Taf. ix. fig. 31, N. H. E). Beneath this has commenced the wider infolding of the ectoblast (fig. 5, 9′), which, extending backward, and subsequently expanding and developing the branchial sacs, ultimately effects a communication with the alimentary cavity (11), and establishes the perma-

Fig. 5.



Enlarged scale of a longitudinal vertical mid-section of an embryo of *Petromyzon Planeri* at the eighteenth day.

* See Owsjannikow, "Die Entwicklungsgeschichte der *Petromyzon fluviatilis*," Bulletin de l'Acad. Imp., St. Pétersbourg, tom. xiv. 1870, p. 325; Calberla, Morpholog. Jahrbuch, Bd. iii. p. 226; Scott (W. B.), Morpholog. Jahrbuch, Bd. vii., erstes Heft, p. 131, "Beiträge zur Entwicklungsgeschichte der Petromyzonten," from which treatise the subject of fig. 5 is taken.

nent oral entry thereto. In the more highly organized cartilaginous fishes (Elasmobranchs) the hæmal permanent mouth, or "tritostome," is also due to involution of the epiblast, forming a sac, beneath the base of the brain, the closed end of the sac coming into contact with the fore end of the alimentary cavity, developing upward the infundibulum. Mr. Balfour sees the rudiment of the hypophysis in a process of the mouth-involution which becomes "constricted off." But he recognizes that the blind anterior end of the alimentary canal—which he terms "throat"—is in close contact with the "pituitary involution." This "involution becomes longer and dilated terminally, while the passage connecting it with the mouth becomes narrower and narrower, and is finally reduced to a solid cord, which in its turn disappears. The remaining vesicle then becomes divided into lobes, and connects itself closely with the infundibulum." (*Op. cit.* p. 190.)

In higher Vertebrates the deuto- or pseudo-pharynx (figs. 1, 2, 4, 8), extending to the parts ultimately modified as a pituitary body or hypophysis with its onward and neurad extensions—the infundibulum, third ventricle, and pineal production—constitutes therewith the modified canal which traverses the interspace between the homologues of the Invertebrate "hæmœsophageal" (fig. 3, 6) and "neurœsophageal" (fig. 3, 3) brain-masses—in Vertebrates the fore brain and following brain-parts. In other words, from the neural side of the embryonal or primary buccal cavity a communication (figs. 1–4, 7, 8) is more or less carried on toward the surface from the part where what is a diverticulum from the primitive closed œsophagus (fig. 5, 8′) seems to be seeking, as it were, its outlet at the neural aspect of the body above a wide interspace (fig. 4, 5) now separating the rudiment of the fore brain (6) from those of the mid (4) and hind (3) brains.

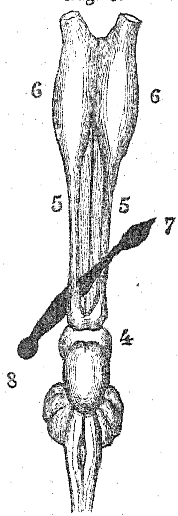
In all Invertebrates with appreciable homologues of these divisions of the Vertebrate brain, the neural mouth (fig. 3, 7) is opened at this part, the primordial attempt to attain it in the Vertebrates is fulfilled, and the communication of such neural mouth with the alimentary canal is completed and becomes the persistent gullet (*ib.* 7, 10).

The proposition, therefore, which I now submit to the Society is, that the conario-hypophysial tract in Vertebrates is the modified homologue of the mouth and gullet of Invertebrates. That the neur- or subœsophageal ganglion, or ganglionic masses, or neural cords (fig. 3, 3, 5), constituting the centres whence are

derived and caudally continued the homologue of the Vertebrate myelon (*ib.* 1), together with the part of the gullet they encompass, are consequently the homologues of the parts of the brain (fig. 2, 4, 3) posterior to the cerebrum (*ib.* 6) and of the ventricle (fig. 4, 5) intervening between the upper and lower ends—pineal (*ib.* 7) and pituitary (*ib.* 8)—of the conario-hypophysial tract. Thus, as it appears to me, is the *Unity of Organization or Composition* vindicated, though in a transitory manner, between the Vertebrate and Invertebrate brain-possessing animals. The foregoing developmental phenomena have mainly guided me to a homological application which, so far as my readings have extended, appears not to have suggested itself.

An obvious difference from the mature Vertebrate is the relative extent of the interspace dividing the fore brain from the mid brain, depending chiefly on the functional relations of the interposed alimentary canal in Invertebrates (fig. 3, 7–10). The proposed homology appears to me to throw some welcome light on the similar though transitory proportions of the same interspace in the Vertebrate, even the Mammalian, embryo, as exemplified in fig. 4. And we now look with interest upon the evidences afforded by mature Vertebrates at the lower end of their scale for any retention of this character—a passing one—in the higher forms.

Fig. 6.



Brain of *Chimæra*.

Fishes, especially the cartilaginous, yield such illustrations. I may refer to Busch's descriptions and figures of piscine brains exemplifying such suggestive characters, in his excellent monograph 'De Selachiorum et Ganoideorum Encephalo'*, from which the illustrations of such character in the brain of the Sturgeon (*Acipenser sturio*), and more especially in that of the *Chimæra monstrosa*, are taken, in figs. 173 and 179 of my 'Anatomy of Vertebrates.' The long cord-like lamellæ continued from the optic lobes (fig. 6, 4) to the cerebral one (*ib.* 6), equal in longitudinal extent both mes- and prosencephalon combined. The so-termed "third ventricle" appears as an elongated widely open channel, the side walls of which (*ib.* 5, 5) are thickened and, expand-

* 4to, 1848.

ing into the cerebral hemisphere, seem to represent the "crura cerebri." They indicate that these so-called cords or tracts, in Vertebrates, may be homologous with the parial cords or tracts girting the gullet and connecting the fore brain (fig. 4, 6) with the hinder masses (*ib.* 8) in Invertebrates; to which pair of intercommunicating tracts the oral end of the gullet in Invertebrates and the conario-hypophysial tract in Vertebrates hold like relations.

Such perception of the homologies above indicated led to thoughts of their bearing upon the following higher generalization.

At the period of my student's career in Paris the biological mind was exercised by the question of "Unity of Plan" or "of Composition" in the Animal Kingdom as exemplified between Articulates and Vertebrates by reversing the position of the former, and turning what was regarded the under or ventral side of the crustacean or caterpillar upward, as shown in fig. 3, so as to correspond with the upper or dorsal side of the Fish or Quadruped. The alleged "Law" was further elucidated, as between Vertebrates and Mollusks, by bending a quadruped so as to bring the pelvis in contact with the nape, and so parallelling it with a cuttle-fish—propositions adopted as demonstrative of their "Unity of organic Plan or Composition" by Geoffroy St. Hilaire.

To the first of these attempts Cuvier opposed the obvious fact that, though the ganglionic cord of the Articulate might be so brought to the relative position, or place, of the spinal cord of the Vertebrate, yet the chief part of the nervous system, or neural axis, universally recognized as "brain" in both, held opposite relations to the alimentary canal, being above the mouth in the Vertebrate and below the mouth in the upturned Articulate (as is shown in figs. 2 and 3).

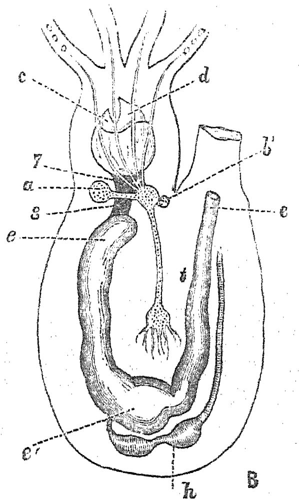
In reference to the second exemplification of the alleged "Unity of Composition," I need only refer to the 'Annales des Sciences Naturelles,' Tom. xix. p. 241, pl. xii. (1830), in which Cuvier refuted Geoffroy's conclusions to his own satisfaction and apparently that of the 'Académie des Sciences,' illustrating his argument by diagrammatic views of the organs which he exposed in an Octopus (fig. 7) and in a doubled-up Quadruped (fig. 8). Among other difficulties which he thereby seemed to demonstrate, was the impossibility of making the brain (figs. 7, 8, *a*) hold a corresponding position in relation to the alimen-

tary canal (*ib.*, *e*), a fact which was deemed by anatomists of the "Positive School" conclusive as against the "Transcendentalists."

Having satisfied myself that there is a way out of the difficulty by rightly determining the homologies of the mouth and gullet in Mollusks and Articulates with recognizable structures in Vertebrates, I have submitted the facts and conclusions which have led me to harmonize the oppositions, and to show that the ingenious idea of MM. Laurencet and Meyranx, adopted and advocated by Geoffroy, was not, in point of fact, open to the objection which relegated it to the limbo of exploded notions, where it seems to have rested now for half a century.

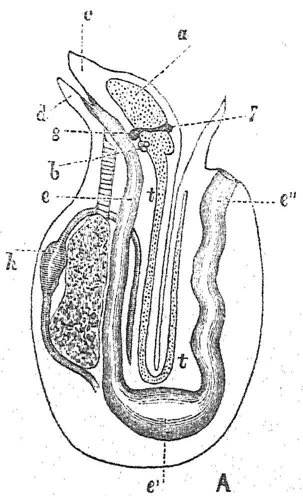
I reproduce the diagrammatic illustrations (figs. 7 and 8) by

Fig. 7.



Cuttle.

Fig. 8.



Mammal.

Schematic views as referred to in the text.

which Cuvier exemplified his objections, in order to show how the homology I have propounded of the "conario-hypophysial tract" affects the argument and conclusion of the great anatomist. The sole liberty I have taken with that diagram (fig. 8) is to add to the brain of the Mammal the tract in question (7, 8); the significance of which to his argument Cuvier as little suspected as have his successors who have devoted time and thought to the higher generalizations of Biology.

After demonstrating, by reference to the Badger, that colour does not indicate the back of an animal, Cuvier proceeds to affirm that naturalists have for the recognition of that aspect a more certain character, viz. the position of the brain :—" Ils ont pour reconnaître les dos un caractère plus certain : c'est la position du cerveau "*.

Now, by the term "cerveau" Cuvier does not here mean the sum of neural expansions usually called "brain," but only one of them, that, viz., which he indicates (as in figs. 7 and 8) by the letter *a* in both Cephalopod and Mammal ; it is the part which is termed the "superœsophageal mass, ganglion, or pair of ganglions" in Invertebrates, and the "cerebrum" or "cerebral hemispheres" in Vertebrates. It is divided, as already remarked, from the "subœsophageal ganglions," completing the totality of the brain in Invertebrates (fig. 4, 3, fig. 7, *b*), by the extension of the gullet and mouth to the aspect of the body which bears relation to, or corresponds with, that of the main centres of the nervous system—such centres answering, as to the parts they supply and, in Articulates (fig. 4, 1), in their continuous extent, to the myelon (fig. 3, 1) and ep- mesencephalon (fig. 2, 1, 3, 4) in Vertebrates. This homology, however, Cuvier did not admit ; and herein he has had the support of later anatomists. With respect to the myelon —" moelle épinière "—marked *t t* in his diagram†, he expressly states that it is peculiar to the type of structure exemplified in his figure A (of the Quadruped)‡. But no evidence is adduced against the homology of the elongate moto-sensory tract, or neural axis, in Articulates, and the elongate moto-sensory but seemingly non-ganglionic tract, or neural axis, in Vertebrates, save their different relative positions in a standing or walking Badger or Beetle. Cuvier assumed, as Gegenbaur and other anatomists have done, that the surface or aspect of the body in progressive motion determines the homology of such surface, and that the surface nearest to which lies the neural axis in Articulates answers to that which is furthest from such axis in Vertebrates. But there are both Vertebrates and Invertebrates in which, during progressive motion, neither the neural nor the hæmal surface is downwards or next the earth.

* *Tom. cit.* p. 251. † *Tom. cit.* pl. xii.

‡ "*t t*, la moelle épinière propre au Mammifère," *tom. cit.* p. 257 (referring to his subject as a representative of a Vertebrate animal).

The subœsophageal mass or ganglions in Cephalopods send off the nerves to the prehensile arms, and are in communication with the viscera, the muscles, and the soft parts of the trunk. Moreover, in Vertebrates this epencephalic homologue is in direct nervous communication with the organ of hearing (*b*, figs. 7 and 8). The fore brain, on the opposite side of the gullet in the Cephalopod (fig. 7, *a*), supplies the nervous masses subservient to the large and complex organs of vision, and also parts which may exercise the sense of smell. But, if the subœsophageal mass, *b*, and the moto-sensory neural continuations of the trunk, *t*, be, in the Cephalopod, homologous with those in the Insect (fig. 3, 1) and Crustacean, the ground on which I predicate, in the Articulate, of the neural aspect of the body, that it answers to that commonly called "dorsal" in Vertebrates, is applicable also to the Mollusk, fig. 7.

Therefore the part which Cuvier indicates in his diagram, and terms brain ("cerveau," *a*), is not a true criterion of the back ("dos"); it occupies in the Cephalopod and other cerebral Invertebrates the aspect of the belly, or tract of the body which I term "hæmal," and which is called the ventral or under part.

To be sure this cannot be predicated of the brain ("cerveau," *a*) of the quadruped. And why? Because the alimentary tract and outward anterior opening which would demonstrate its holding a position opposite to that of the rest of the nerve-centres has been atrophied, and exists as an arrested residuary embryonal part (figs. 3 and 8, 7–8). It is the superadded respiratory organization in connection with the oral end of the alimentary canal and the concomitant opening of the mouth in a new position, in the Vertebrate, which turns the cerebrum to the side occupied by the rest of the nerve-centres—in other words, to the neural aspect of the body. Individual development being achieved, the Vertebrate becomes "hæmastomous," the Invertebrate remains "neurostomous."

At the embryonal stage of the higher subclass at which the primary mouth was continued across the brain, the "Unity of Plan" between the Vertebrate and Invertebrate animal was exemplified; and that "unity" is, in the main, preserved under the recognition of the neural and hæmal aspects of the body, as shown in figs. 2 and 3, representing the Articulate and Vertebrate types.

In the view of the homologous surfaces of the Invertebrate and Vertebrate bodies as determined by that which may happen to be the upper surface in horizontal station and progression, which surface is accordingly termed "dorsal," the opposite or under surface being "ventral," the chief nerve-mass in the Articulate (fig. 3, 6), called "cerveau" by Cuvier, poses as the homologue of the brain in the Vertebrate; and not only so, but being the only part of the central nerve-mass which is "dorsal" in position, or "above" the alimentary canal, it might be entitled, according to the above homology of the body-surfaces, to be the homologue of the entire central nerve-mass (my "myelencephalon") in Vertebrates, which is also "dorsal;" while the ganglionic nerve-cords in Articulates would be in the opposite homological category.

Accordingly the accomplished Anatomical Professor at Heidelberg, in logical concord with such determination of homologous surfaces, holds the so-called "superœsophageal ganglion" of the Articulate to be, or to represent, the whole myelencephalous tract in the Vertebrate. With Gegenbaur*, as with Cuvier, the "spinal cord" is therefore peculiar to Vertebrates, being "dorsal" in position; it bears no true homology with the so-called "ventral" cords, whether ganglionic or not, in Invertebrates.

Dohrn†, while admitting the homology or equivalency of the superœsophageal ganglions, subœsophageal ganglions, and sub- or ventral cords therefrom continued, whether ganglionic or otherwise, in Annelids and Arthropods, with the myelencephalous tract in Vertebrates, notwithstanding the opposite sides of the body which they seem to hold, has recourse to ideal ancestral forms in order to reconcile the differences as to relative position shown by the actual or modern subjects‡.

My contention is that the true grounds for determining the homology in question are not the positions of the body which may be assumed by the living animal, but the relative positions to such body of the central parts of the nervous and vascular systems, which relations I have expressed by the terms "neural" and "hæmal." The convenience of these terms or signs is exempli-

* 'Grundriss der vergleichenden Anatomie,' 8vo, p. 264.

† 'Ursprung der Wirbelthiere,' &c.

‡ I concur with the remarks by Balfour, *loc. cit.* p. 167, on Dohrn's hypothesis, and deem any other objection superfluous.

fied by the trouble, not to say perplexity, which arises when characters, or developmental phenomena, repeated in Vertebrates and Articulates, are endeavoured to be expressed or expounded on the "dorsal" and "ventral" homological hypothesis.

Balfour, for example, in his keen and accurate views of the primary growths of the myelon, in Elasmobranchs, traces the formation of the central cavity by the "dorsal" folding of the lateral halves of the primitive open canal, which includes the grey matter and carries in also a fold, now become the lining of the cavity, of the embryonal ciliate epiderm.

The primal nerve-roots are, or are attached to, free margins of the dorsal folds, and become the "dorsal," or, in anthropotomy, the "posterior" roots of the spinal nerves. The white matter of the myelon becomes external and lies in greater proportion along the under, or ventral, or anthropotomically "anterior," part, than on the "dorsal" part of the myelon.

Now comes the difficulty arising from the non-appreciation of the homology of the conario-hypophysial infundibular tract with the annulose gullet. "The transverse section of the ventral nervous cord of an ordinary segmented Annelid consists of two symmetrical halves placed side by side. If by a mechanical folding the two lateral halves of the nervous cord became bent towards each other, while into the groove between the two the external skin became pushed, we should have an approximation to the vertebrate nervous system." .... "If this folding were then completed in such a way that the groove, lined by external skin and situated between the two lateral columns of the nervous system, became converted into a canal, above and below which the two columns of the nervous system united, we should have in the transformed nervous cord an organ strongly resembling the spinal cord of Vertebrates"*. But a resemblance, however strong, between the two parts or organs is not, of itself, a ground for predicating homology. For, as the accomplished developmentalist proceeds, "It is well known that the nerve-cells are always situated on the ventral side of the abdominal nerve-cord of Annelids, either as a continuous layer, or in the form of two, or more usually, three bands. The dorsal side of the cord is composed of nerve-fibres or white matter. If the folding I have supposed were to take place in the Annelid nervous-cord, the grey and white matters would have very nearly the same relative situations as they have in the

* Balfour, *op. cit.* p. 165.

Vertebrate spinal cord. The grey matter would be situated in the interior and line the central canal, and the white matter would nearly surround the grey. The nerves would then arise, not from the sides of the nervous cord as in existing Annelids, but from its extreme ventral summit "*.

Parts of the important organs "spinal marrow" and "abdominal cords," ganglionic or otherwise, would doubtless hold the same relative situations in an abstract view of the structures, irrespective of their assumed relative positions in the Annulate and Vertebrate bodies; but in relation to the accepted position of the nerve-centres in the two groups they would hold opposite relative situations in and to the body; the extreme summits of the primitive folds giving origin to the nerves would be dorsal in the Vertebrate, and ventral in the Annulate modifications of the animal structures.

Obliterate the mouth and part of the alimentary canal dividing the fore brain from the hind brain in Annulates, and the parts of the homologue of the myelencephalon ("cerebro-spinal tract" or abdominal nerve-cord) become wholly on the neural aspect of the body, as in Vertebrates. In both divisions the infolding of the side walls completing the central canal occurs on the neural side. In both the nerves arise from the neural summits of such infoldings; and in both the "external skin" would pass from the neural side of the groove into the central (then becoming) ciliate canal. In both the hæmal side of the cord would manifest an excess of the "white matter;" and this with the opposite predominant grey matter would present not "very nearly," but the very same relative positions to the body of the animal containing them (compare figs. 2 and 3).

Of these propositions, the base or support is the homology of the pineal, third ventricular, infundibular, pituitary residuary modifications in the Vertebrate brain with the persistent functional canal traversing the homologous tract in the Annulate or Articulate brain†.

* Balfour, *op. cit.* p. 165.

† I have elsewhere ('Archetype of the Vertebrate Skeleton,' 8vo, 1848, p. 2) pleaded in favour of single substantive "terms" in place of "descriptive" phrases," and may here cite, as synonyms of "myelencephalon"—"nervous system" (p. 165), "cerebro-spinal nervous system" (p. 99), "central nervous system" (p. 100), "nervous part of the brain and spinal cord" (p. 100); again, as synonyms of "myelon"—"spinal marrow," "spinal cord," "abdominal nerve-

As animals descend in the scale, the instinctive or reflex actions of the nervous system predominate over those that are "willed," or the voluntary actions.

In both Vertebrates and Invertebrates, as a rule, the parial limbs diverge from their arches nearer the neural than the hæmal sides of the trunk—nearer to the centres whence their nerves originate. In Vertebrates the joints or segments of the limbs bend toward the hæmal aspect; in Invertebrates they bend from the hæmal aspect: and thus the most frail and precious of the organic systems, namely the neural axis, is brought in Arthropods towards the least exposed and safest surface of the body, that, viz., which is downward, next the ground—therefore called the "belly," or ventral surface or aspect. When the myelencephalous tract runs along the most exposed, dorsal, side, it receives an immediate protection by a vertebral column. But the surfaces or aspects of the body which are truly homologous in the Snake and Caterpillar are the *neural* and the *hæmal*, not the *dorsal* and the *ventral*.

The Neuroptera of Madeira and the Canary Islands.

By Robert M'Lachlan, F.R.S., F.L.S., &c.

[Read December 1, 1881.]

It has always appeared to me that attempts to work out, group by group, the fauna or flora of special countries or districts are duties to which the attention of naturalists should be especially directed. It is by means of such attempts that we are enabled, little by little, to grasp broad generalizations on the probable origin of the productions of certain districts, to ascertain the geographical distribution of species, and to form some idea of the possible means whereby, through a process of evolution, certain forms have acquired their existing characteristics as distinguishing them from others to which they are most closely allied.

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cord" (p. 165), "Annelid nervous cord" (*ib.*); also, as synonyms of "myelonal canal"—"medullary canal"(p. 128), "neural canal" (p. 100), "central canal of the nervous system," equivalent to "myelencephalous canal;" "spinal canal" (p. 99), which, in surgery, is a synonym of "vertebral canal." The pages here quoted refer to the 'Elasmobranch Fishes' of Balfour.

If this be true regarding the value of local monographs for countries or districts separated arbitrarily by political frontiers, or physically by mountain-ranges, &c., such monographs become of far greater value when they concern small islands, or groups of islands, separated from the nearest mainland by wide distances and great depths of sea or ocean. Nothing could more forcibly demonstrate this than the labours of our late much lamented colleague T. Vernon Wollaston, who for a period of nearly thirty years devoted his energies, impaired though they too often were by periods of great bodily weakness, to an investigation of the Coleopterous fauna of the various Atlantic islands (beginning with Madeira). The results of his investigations (and of those of willing assistants), given to the public in a number of volumes, form by far the most valuable series of works of this nature that have ever been published, notwithstanding that the ideas held by our late colleague on the subject of variation of species may, in the opinion of many of us, have induced in him erroneous generalizations. He gave us the facts, however much his own deductions therefrom may be disputed.

In the present paper I shall endeavour to put together all that is known concerning the Neuropterous insects (using the term in its Linnæan sense) of the islands under consideration; and the remarks that follow will show in how much we are indebted for our knowledge to T. V. Wollaston.

In endeavouring to state briefly the sources whence our present information has been derived, it will be well to treat the Madeiras and Canaries separately *.

Madeira.

This favoured island has been so much the resort of invalids from all countries, that it would have been singular if amongst them there had been no entomologists. On the other hand, it has been but little explored by entomologists who did not seek to restore or ameliorate impaired health; but there has been one prominent exception to this, to which attention will presently be drawn.

In 1793 Fabricius described in the 'Entomologia Systematica,' vol. ii. p. 93, a *Myrmeleon catta* from Madeira, in the collection of Sir Joseph Banks. The type of this (with the other Banksian

* I must here acknowledge the assistance I have derived from the rich library of the Royal Geographical Society.

insects) is now in the British Museum, having been presented to that Institution some years ago by this Society.

From that time up to 1815 I find no reference to Neuroptera from the island; but in the latter year there was published anonymously at Haddington a curious little book called 'The Traveller's Guide to Madeira and the West Indies:' it bears no date on the titlepage; but the preface is dated "Jan. 1815." Speaking of Dragonflies, the author says "there are several kinds, and the largest sort 3 inches long" (*Anax formosus* in all probability).

In Bowdich's 'Excursions in Madeira and Porto Santo,' 1825, p. 169, we find a reference to an "*Æschna* approaching *grandis*, and greatly resembling the species figured by Roesel, t. 2, Insect. Aquat. tab. ii. fig. 1." Roesel's insect is *Æschna cyanea* of modern authors; and there can be little doubt that the species observed by Bowdich was likewise *Anax formosus.*

In 1842, Rambur, in his 'Histoire des Insectes Névroptères,' indicates *Agrion pumilio* from Madeira (p. 278), which reference we find reproduced in De Selys-Longchamps and Hagen's 'Revue des Odonates d'Europe,' 1850, p. 184; and at p. 396 of this latter work is a reference of the occurrence in Madeira of *Libellula striolata*, *Anax formosus*, and *Agrion maderæ* (Rambur, MS.) in addition.

Harcourt, in his 'Sketch of Madeira,' published in 1854, alludes, at p. 125, to "several kinds of *Libellula.*"

In De Selys-Longchamps and Hagen's 'Monographie des Gomphines,' 1857, p. 138, is a reference to a species of *Gomphus*, which still remains doubtful.

In vol. xii. of the 'Linnæa Entomologica,' published in 1858, we find notices by Hagen of two species of Termitidæ, viz. *Calotermes præcox* (p. 51), received by Wollaston from Heinecken, and *Termes lucifugus* (pp. 178–179), with interesting accounts of the habits as observed by Hartung.

When Wollaston first left England for Madeira in 1847, it was probably with the hope that he should not be compelled to revisit the island for health's sake. As is well known, this was not to be; and on the occasion of his second visit he resolved to collect materials for an 'Insecta Maderensia,' remaining throughout the year for that purpose. This work was published in 1854, so far as the Coleoptera were concerned; but the author abandoned the idea of a general Insect Fauna of the islands, and his materials

for other orders formed the subjects of scattered papers by various writers. The Neuroptera were undertaken by Hagen; and in 1865, in vol. ii. of the 'Entomologists' Monthly Magazine,' appeared his 'Neuroptera of Madeira' (pp. 8–11, 25–28, 59–62, and 75–81), in which all the information at that time possessed was embodied. Hagen there notices or describes 26 species, of which only very few had been previously recorded as inhabiting the island. This is the groundwork of our knowledge of the Neuroptera of Madeira. [The part relating to the Trichoptera was also published almost simultaneously in the 'Stettiner entomologische Zeitung,' vol. xxvi. pp. 217–222.]

Beyond the necessary references to species in monographic works on special groups, nothing has since appeared.

In November and December 1880 my friend the Rev. A. E. Eaton, M.A., visited both Madeira and the Canary Islands, the first time that either had been explored by an experienced Neuropterist. Mr. Eaton was happily not driven thence by considerations of health; yet from other causes his movements were not altogether untrammelled, and the time of year was most unfavourable. His stay in Madeira was only from the 17th to the 30th of November (1880); nevertheless in those few days he collected 20 species, several of which were previously unknown. All the materials he generously placed at my disposal; and they formed the inducing cause of the production of the present paper. Let us hope that he, or some other equally experienced Neuropterist, may be able to explore the islands in the favourable season!

Canary Islands.

If our information be yet meagre for Madeira, it is far more so for the Canary Islands. Madeira is the sanatorium for the world. The Canary Islands are now forbidden to acknowledged invalids *from any cause*, although formerly the restrictions would not appear to have been so severe; for Heer, Hartung, Wollaston, and probably others, all in indifferent health, explored the islands. So also did the brothers Crotch and others, who could not be considered invalids; but almost the whole of these explorers confined their attention mainly to Coleoptera. I have only been able to compile the following references, but have reason to believe that both material and information are contained in French museums and publications that I have not been able to consult.

Probably the earliest work that contains any reference to Neuroptera is the Baron Bory de St. Vincent's 'Essai sur les Isles Fortunées et l'antique Atlantide,' published at Paris in "An XI." of the Revolution (=1803). At p. 369 we find references to 6 species of Neuroptera, including 4 Dragonflies, 1 "Hémérobe," and 1 *Myrmeleon*, all of which are extremely vague; all were possibly from Teneriffe.

Between 1836 and 1844 inclusive appeared the ponderous 'Histoire Naturelle des Iles Canaries,' by MM. P. Barker-Webb et Sabin Berthelot, the Neuropterous portion of which was worked out by Brullé, and occupies pp. 82, 83 of vol. ii. pt. 2. In it 13 species are noticed, including 5 Dragonflies, 4 Ant-lions, 4 Lacewing flies, several species being described as new; and with only one or two exceptions this has remained our sole guide to a knowledge of this portion of the insect productions of the islands. No indications of special islands are given. Webb and Berthelot's work has not escaped severe criticism: not the least pungent is that given by Wollaston in his 'Coleoptera Atlantidum,' 1865, introductory remarks pp. xx–xxii, who goes so far as to doubt whether some of the insects indicated may not have been really from Madeira. In some respects it is fortunate that the greater part of the types exist in the museum attached to the Jardin des Plantes at Paris; and I am under great obligations to Professor Emile Blanchard for having allowed me to examine, at home, the types of Neuroptera, including most of the species indicated.

In Burmeister's 'Handbuch der Entomologie,' vol. ii. pt. 2, p. 857 (1839), *Libellula chrysostigma* is described from Teneriffe.

In the Neuropterous portion of the 'Reise der Novara,' 1865, Brauer incidentally notices *Anax Parthenope* as occurring in Teneriffe (it is presumed there is no confusion with *A. formosus*, already recorded by Brullé from the islands, or *A. mauricianus*). Another Æschnide, *Cyrtosoma ephippigerum*, is mentioned by Hagen in 'Verhandl. z.-b. Gesellsch. Wien,' vol. xvii. p. 31, as having been taken at sea off the Canaries.

Mr. Eaton's brief visit to the islands in 1880 occurred between the 6th and the 29th December: from the 6th to 12th he was in Grand Canary, from the 14th to 28th in Teneriffe; and a single day (the 29th) was devoted to the island of Palma (resulting in the discovery of an apparently peculiar species of *Chrysopa*). During this short stay he collected 18 species, included in which are several new forms; and the two large eastern islands, Lanzarote and

Fuerteventura†, and the smaller and western, Gomera and Hierro, were not visited.

I now proceed to summarize, in a tabular form, the species known to occur in Madeira and the Canaries, enumerated in the details that follow.

Name.	Madeira.	Canaries.	Occurring also in Europe.
TRICHOPTERA.			
LIMNOPHILIDÆ.			
Limnophilus affinis, *Curt.*	*	....	*
Mesophylax aspersus, *Ramb.*, var. canariensis, *M'Lach.*	....	*	?
—— oblitus, *Hag.*	*		
HYDROPSYCHIDÆ.			
Hydropsyche maderensis, *Hag.*	*		
Polycentropus flavo-strictus, *Hag.*	*		
Tinodes grisea, *Hag.*	*		
—— cinerea, *Hag.*	*		
—— canariensis, *M'Lach.*	....	*	
—— merula, *M'Lach.*	*		
RHYACOPHILIDÆ.			
Pseudagapetus (?) punctatus, *Hag.*	*		
HYDROPTILIDÆ.			
Agraylea (?) insularis, *Hag.*	*		
Hydroptila (?) sp.	*	*	
Stactobia atra, *Hag.*	*	*	
Oxyethira sp.	*		
PLANIPENNIA.			
HEMEROBIIDÆ.			
Micromus aphidivorus, *Schrank*	*	....	*
Hemerobius elegans, *Steph.*	....	*	*
—— sp.	*	*	?
—— nervosus, *Fab.*	*	*	*
CHRYSOPIDÆ.			
Chrysopa vulgaris, *Schneid.*	*	*	[*
—— fortunata, *M'Lach.*	....	*	
—— subcostalis, *M'Lach.*	....	*	
—— atlantica, *M'Lach.*	*	*	
—— flaviceps, *Brullé*	....	*	

† Heer, in his Catalogue of Insects appended to Hartung's "Die Geologischen Verhältnisse der Inseln Lanzarote und Fuertaventura" (Neue Denksch. naturf. Gesellsch. Zürich, 1856), mentions no Neuroptera.

Name.	Madeira.	Canaries.	Occurring also Europe.
PLANIPENNIA (*continued*).			
MYRMELEONIDÆ.			
Palpares hispanus, *Hag.*?	*	*	?
Formicaleo catta, *Fab.*..................	*	*	
Myrmeleon alternans, *Brullé*	*	*	
—— distinguendus, *Ramb.*............	....	*	*
CONIOPTERYGIDÆ.			
Coniopteryx sp.	....	*	?
—— pulchella, *M'Lach.*	....	*	
PSEUDO-NEUROPTERA.			
TERMITIDÆ.			
Calotermes præcox, *Hag.*...............	*		
Termes lucifugus, *Rossi*	*	....	*
PSOCIDÆ.			
Psocus adustus, *Hag.*	*		
—— personatus, *Hag.*	*	*	
Stenopsocus cruciatus, *L.*...............	*	....	*
Cæcilius marmoratus, *Hag.*............	*		
—— Dalii, *M'Lach.*.....................	*	*	*
Peripsocus alboguttatus, *Dalm.*	*	....	*
EPHEMERIDÆ.			
Cloëon dipterum, *L.*.....................	*	*	*
Baëtis rhodani, *Pict.*	*	*	*
ODONATA.			
Palpopleura marginata, *Fab.*	....	*	
Sympetrum striolatum, *Charp.*	*	*	*
—— Fonscolombii, *Selys*...............	*	*	*
Orthetrum (?) chrysostigma, *Burm.*...	....	*	
Platetrum depressum, *L.*??	....	??	
Trithemis arteriosa, *Burm.*	....	*	
Crocothemis erythræa, *Brullé*.........	....	*	*
Gomphus sp................................	*	......	?
Anax formosus, *V. der Lind.*	*	*	*
—— mauricianus, *Ramb.*?	*		
—— Parthenope, *Selys*	....	*	*
Cyrtosoma ephippigerum, *Burm.* ...	....	*	*
Ischnura pumilio, *Charp.*	*	....	*
—— senegalensis, *Ramb.*	*		

An analysis of the above Table shows that 53 species are known from the islands: 37 are found in Madeira and 31 in the Canaries, 16 being common to both. Of these 53 species, 19 are known inhabitants of the continent of Europe, and 6 others are doubtful in this respect, owing to imperfect identification; 4 Odonata (viz. *Palpopleura marginata, Trithemis arteriosa, Anax mauricianus,*

and *Ischnura senegalensis**) are African species not known to occur in Europe.

Thus we find about 25 species that, so far as our present knowledge serves, are peculiar to the islands. It is quite possible that before the destruction of the forests, when the islands were better watered, the number of species was greater; it is also certain that much yet remains to be discovered. For instance, it is difficult to believe that the smaller forms of Perlidæ (*Leuctra* and *Nemoura*) are totally absent; so also it is difficult to believe that no Termitidæ exist in the Canary Islands; and several other examples might be cited.

That some of the purely terrestrial forms may have been introduced from Europe is very possible; on the other hand, I see no reason to doubt that some of the European forms mentioned may be considered true natives of the islands also; and it is still further possible that some forms apparently peculiar to the islands may yet be discovered in Southern Europe or North-western Africa; for in some respects we know less of the Neuropterous fauna of these regions than we now do of the islands. It is worthy of remark, however, that (with one possible exception) the whole of the species of Trichoptera are peculiar to the islands although belonging to familiar European genera, and that they all inhabit running water in the larval stage. These remarks show that it would be hasty to attempt generalizations from the Neuropterous fauna alone. With the Coleoptera it is different; and those who wish may obtain generalizations on these, from two very opposite points of view, by consulting Mr. Wollaston's 'Coleoptera Atlantidum' (and his other works), and Mr. Wallace's 'Geographical Distribution of Animals.'

TRICHOPTERA.

Limnophilidæ.

Limnophilus affinis, *Curtis*. (*L. cinctus*, Hag. Ent. Month. Mag. ii. p. 75; Stett. ent. Zeit. 1865, p. 217.—*L. affinis*, M'Lach. Revision & Synopsis, p. 82.)

Madeira (*Wollaston*).

Renewed examination has not revealed any tangible differences between the Madeiran examples (*L. cinctus*) and ordinary *L. affinis*. There is a certain amount of not-describable colour-variation

* To these it is possible that *Libellula chrysostigma*, Burm., should be added. Compare the detailed remarks on that species at pp. 177–179, *post*.

in the Madeiran form; and perhaps the intermediate appendages of the ♂ are slightly longer and less curved.

MESOPHYLAX, n. g. (=*Stenophylax*, Kol., partim).

Very closely allied to *Stenophylax* typically; differs especially in the spur of the anterior tibiæ of ♂ being so much reduced as to be microscopic, whereas the corresponding spur in the ♀ is long; hence the spur-formula is *quasi* 1, 3, 4 ♂, and 1, 3, 4 ♀; but the first joint of the anterior tarsi in the ♂ is as long as in the ♀. As other differences, it may be said that the palpi are more slender than in *Stenophylax* typically, the pronotum more developed, the median lobe of the vulvar scale notched or bifid.

The type of this genus is *Stenophylax aspersus*, Rambur. When I wrote my 'Revision and Synopsis of European Trichoptera,' I had not noticed the peculiarity in the spur of the anterior tibiæ of the ♂, and therefore placed *aspersus* in the typical group (*vide* Revision and Synopsis, p. 114) of *Stenophylax*. Renewed examination proves that this spur is virtually obsolete: it can only be detected microscopically, and when the tibiæ are in a particular position; the basal joint of the tarsi, however, is not at all abbreviated.

The Madeiran *Stenophylax oblitus*, Hagen, will fall into the same genus.

MESOPHYLAX ASPERSUS, *Rambur*, var. CANARIENSIS (*M'Lach.*).

Canaries: hills beyond San Mateo, Grand Canary, at a stream, 4550–4650 feet, 11th December (*Eaton*, 2 ♂).

The most remarkable feature in these Canarian examples is their *very small* size; expanse, ♂, 22–25 mm. (instead of 31–33 mm. in the typical form*). Upon comparing them, they appear to be identical in form and colours, and also in anal structure so far as this can be defined; but the superior and intermediate appendages cannot be examined in these dry individuals. The locality and altitude at which the examples were found prove that the form is a true native. In the absence of any obvious structural differences it would be rash to consider it a species; but it may justly be placed as an insular race.

Having made this unexpected discovery, Mr. Eaton, as is his custom, at once searched the stream for larvæ or cases, and succeeded in finding the larval condition of one of the Limnophilidæ;

* I have seen, however, a ♂ of *M. aspersus* from Spain in which the expanse is only 26 mm.

and there can, I think, be little doubt that it pertains to the same insect. The cases are cylindrical slightly curved tubes formed of coarse sand-grains, 14–15 mm. long, the diameter at the mouth-end about twice that at the tail-end. The larva has a black head and thoracic segments, and dull greenish abdomen; legs testaceous: it is of the true Limnophiliform type. The temperature of the water where they were found was 51° Fahr.

The type form of *aspersus* is essentially a South-European species, and especially given to concealing itself in caves. A much larger and much paler form is found further north, and is not uncommon in some localities in Switzerland &c.

MESOPHYLAX OBLITUS, *Hagen*. (*Stenophylax oblitus*, Hag. Ent. Month. Mag. ii. p. 76; Stett. ent. Zeit. 1865, p. 217; M'Lach. Revision & Synopsis, p. 115, pl. xiii.)

Madeira (*Wollaston*).

In my 'Revision and Synopsis,' p. 116, I called attention to the minute condition of the spur on the anterior tibiæ of the ♂, but had not then noticed that *S. aspersus* was precisely in the same condition. I now see that there is close relationship between *oblitus* and *aspersus*. The contour of the anterior wings of the former is considerably different, and so are the anal parts at first sight; but closer examination shows that the latter can be quite homologized with the same parts in *aspersus*; the bifid middle lobe of the vulvar scale of the ♀ is another point of resemblance. There is, however, no specific connection whatever between the two species.

HYDROPSYCHIDÆ.

HYDROPSYCHE MADERENSIS, *Hagen* (Ent. Month. Mag. ii. p. 77, Stett. ent. Zeit. 1865, p. 219; M'Lach. Revision & Synopsis, p. 367, pl. xxxix.).

Madeira (*Hartung*, *Wollaston*). Generally distributed about streams in November, especially in the north of the island (*Eaton*).

Eaton brought a dozen examples of both sexes, varying much in size and in intensity and variety of markings. Apparently a truly endemic species, of which the nearest European ally is probably *H. angustipennis*, Curt., notwithstanding the colour-differences.

POLYCENTROPUS FLAVO-STICTUS, *Hagen* (Ent. Month. Mag.

ii. p. 79, Stett. ent. Zeit. 1865, p. 220; M'Lach. Revision & Synopsis, p. 400, pl. xlii.).

Madeira (*Wollaston*). Near Funchal, 19th November (*Eaton*).

TINODES GRISEA, *Hagen* (Ent. Month. Mag. ii. p. 79, Stett. ent. Zeit. 1865, p. 221; M'Lach. Revision & Synopsis, p. 414, pl. xliv.).

Madeira (*Wollaston*, ♀); at a "levada" on the cliff below Sant' Anna, 26th November (*Eaton*, 2 ♂).

This species was described from a ♀ only. I believe I am right in coupling therewith two ♂ collected by Eaton. If so, the affinity with *T. cinerea* is much greater than anticipated. The clothing of the head and anterior wings is entirely golden; the size is larger (but not so much as in the ♀ type). The anal appendages arranged quite after the same plan. The principal difference consists in the parts termed "intermediate" appendages in my "Revision." In *cinerea* these parts, if viewed laterally, are subcylindrical, not dilated, and regularly curved downward: in what I consider the ♂ of *grisea* these parts, viewed in the same position, are very much dilated and somewhat flattened in the apical portion, with a conspicuous tooth (distinct from the spines) on the upper edge that seems to escape from between the two appendages; the processes of the inferior appendages are stronger, especially the process of the lower edge, if viewed from beneath. Expanse 14–16 mm. (20 mm. in the ♀ type).

Amongst the large number of *T. grisea* collected by Eaton, I detect only these two supposed *cinerea*, which occurred in company with them.

TINODES CINEREA, *Hagen* (Ent. Month. Mag. ii. p. 78, Stett. ent. Zeit. 1865, p. 220; M'Lach. Revision & Synopsis, p. 416, pl. xliv.).

Madeira (*Wollaston*); generally distributed and common about small streams in November (*Eaton*).

Eaton brought about thirty examples of both sexes. They vary greatly in size, irrespective of sex (expanse $10\frac{1}{2}$–16 mm.).

TINODES CANARIENSIS, n. sp.

A close ally of *T. cinerea*; apparently differing therefrom only in slight modifications of the anal structure in the ♂. The superior appendages are not perceptibly dilated toward the base, almost filiform throughout; the intermediate appendages appear to have a process below the apex, slightly exceeding them in

length; the process of the lower edge of the inferior appendages is very slender, greatly curved, its apex obliquely pectinate (*i. e.* with four or five teeth successively decreasing in length from the upper).

Canaries: a stream on the hills beyond San Mateo, Grand Canary, 4550–4650 feet, 11th December (*Eaton*, 1 ♂).

Amongst European species *T. unicolor*, Pict., has the superior appendages equally without any perceptible dilatation towards the base; but there is no close affinity otherwise.

In the two groups of islands with which we are now concerned, there thus appear to be three closely allied species of *Tinodes*, a genus that bids fair to become protean in allied forms when the localities in which it delights shall have been fully explored, and more especially as regards the Mediterranean district.

TINODES MERULA, n. sp.

Almost totally deep black, including the clothing of the head, thorax, and wings. Antennæ narrowly annulated with yellowish; articulations of tarsi narrowly yellowish; ovipositor of ♀ elongate, testaceous. Anterior wings having the apex slightly elongate; apical fork No. 3 long and narrow, No. 4 very long and broad; membrane iridescent. Expanse 12–13 mm.

Madeira: streamlet between Cama dos Lobos and Cabo Girão, 1780 feet, 20th November, 1 ♀; "levada" above Funchal, 3100 feet, 23rd November, 1 ♀ (*Eaton*).

In its black coloration this greatly resembles a large species of *Lype*; but it is a true *Tinodes*. Descriptions of species of *Tinodes* from the ♀ only must always be unsatisfactory, and are to be deprecated as a rule. But the number of *black* species of the genus is so small, that in working out an insular fauna, such as this, it is advisable to relax what should otherwise be the rule. *T. merula* must prove distinct, whatever may be its nearest relative amongst the black European forms.

RHYACOPHILIDÆ.

PSEUDAGAPETUS? PUNCTATUS, *Hagen*. (*Agapetus punctatus*, Hag. Ent. Month. Mag. ii. p. 80; Stett. ent. Zeit. 1859, p. 163, 1865, p. 221.—*P.* (?) *punctatus*, M'Lach. Revision & Synopsis, p. 485, pl. li.)

Madeira (*Wollaston*).

A *Pseudagapetus* according to the undilated intermediate legs

of the ♀, but an *Agapetus* according to the neuration of the posterior wings. Further materials are necessary before constituting a special genus for its reception.

HYDROPTILIDÆ *.

AGRAYLEA (?) INSULARIS, *Hagen*. (*Hydrorchestria insularis*, Hag. Stett. ent. Zeit. 1865, p. 219.—*A. insularis*, Eaton, Trans. Ent. Soc. Lond. 1873, p. 148; M'Lach. Revision & Synopsis, p. 508.)

Madeira (*Wollaston*).

This supposed species rests solely on the authority of a single ♀ example submitted to Hagen, but which was lost in the process of working-out. I have seen no species of *Agraylea* from the islands. The colour, as described, agrees with that of *Stactobia atra*.

HYDROPTILA (?), n. sp.

Madeira: between Cama dos Lobos and Cabo Girão, 1780 feet, 20th November; cliff below Sant' Anna, 500 feet, 26th November, (*Eaton*, 2 ♂).

Canaries: near Teror, 1600 feet, 9th December, and near San Mateo, about 4600 feet, 11th December, Grand Canary; in the botanic garden, Orotava, and a valley N.E. of Santa Cruz, 1300 feet, 25th December, Teneriffe (*Eaton*, many examples).

This insect will probably form a new genus. Although closely allied to *Hydroptila* (restricted), and with apparently the same neuration of the wings, it differs in the absence of the elevated lobes on the posterior portion of the head. I believe the same generic form is known to me from the French Pyrenees.

The specific identity of the Madeiran and Canarian examples appears probable; but the materials for the former are barely sufficient.

STACTOBIA ATRA, *Hagen*. (*Hydroptila atra*, Hag. Stett. ent. Zeit. 1865, p. 218; Ent. Month. Mag. ii. p. 77.—*Orthotrichia*

* The minute insects comprising this family require the strongest possible daylight for satisfactory elucidation. The month (November) in which this portion of the paper was written was the least favourable in this respect. In order, therefore, no longer to delay the publication of the paper (most of which has been written for many months), minute description of the Hydroptilidæ is reserved for the forthcoming additional Supplement to my 'Revision and Synopsis of the Trichoptera of the European Fauna.'

atra, Eaton, Tr. Ent. Soc. Lond. 1873, p. 142; M'Lach. Revision & Synopsis, p. 520.)

Madeira (*Wollaston*, 1 example); between Cama dos Lobos and Cabo Girão, 1780 feet, 20th November, and cliff below Sant' Anna, 500 feet, 26th November (*Eaton*, many examples).

Canaries: stream near Teror, 1600 feet, 9th December, Grand Canary (*Eaton*, 1 ♀).

I find that this insect is a true *Stactobia*, but much larger than the European forms of the genus.

OXYETHIRA, n. sp.

Madeira: Ribiero Frio, near Faial, 300 feet, 25th November, and cliff below Sant' Anna, 500 feet, 26th November (*Eaton*, four examples).

Apparently distinct from the European *O. costalis*.

PLANIPENNIA.

HEMEROBIIDÆ.

MICROMUS APHIDIVORUS, *Schrank*. (Hag. Ent. Month. Mag. ii. p. 59.)

Madeira (*Wollaston*).

HEMEROBIUS ELEGANS, *Stephens*.

Canaries: near Las Palmas, Grand Canary, beaten from olive, 6th December (*Eaton*).

The single example is strongly marked, resembling the variety *H. Marshami*, Steph. Possibly introduced?

HEMEROBIUS, sp.? (*H. humuli*, L., Hag. Ent. Month. Mag. i. p. 60.)

Madeira (*Wollaston*, 1 ♀); near Funchal, 19th November (*Eaton*, 1 ♀).

Canaries: in the botanic garden at Orotava, Teneriffe, 15th December (*Eaton*, 1 ♀).

In all the three examples examined there are four sectors in the anterior wings (five sectors in one anterior wing, four in the other, in that from Teneriffe); *H. humuli* normally has only three, and the *facies* is slightly different. It would not be prudent to give a new name without seeing the ♂.

HEMEROBIUS NERVOSUS, *Fab.* (*H. hirtus*, Brullé, Hist. Canar. ii. pt. 2, p. 83, nec L.—*H. nervosus*, Hag. Ent. Month. Mag. ii. p. 60.)

Madeira (*Wollaston*); near the Ribiero de São Jorge, 26th November (*Eaton*).

Canaries (*Webb et Berthelot, Wollaston*).

From Madeira I have seen only the ♀. Brullé's type of *H. hirtus* is fortunately a ♂; otherwise its identification would have remained impossible, owing to its condition. There is also a ♂ in the British Museum amongst Wollaston's Canarian captures.

More materials are desirable. *H. nervosus* belongs to a group of species that can practically only be separated by the appendages of the ♂; and in some respects those of the Canarian examples do not appear to completely agree with those of *nervosus* of Northern Europe (but the position in those I have seen is not favourable for examination), and appear intermediate between *nervosus* and *subnebulosus*. Caution is necessary; for in examples from the Pyrenees and the French Alps in my collection a new species intermediate between those just mentioned appears to be clearly represented, but not identical with the Canarian specimens. Furthermore there is a form apparently common in the Swiss Alps (but of which I do not seem to have the ♂), in which the ♀ has a short upturned ovipositor.

CHRYSOPIDÆ.

CHRYSOPA VULGARIS, *Schneider*, et var. MICROCEPHALA, *Brauer*. (*Hemerobius albus* and *H. perla*, Brullé, Hist. Canar. ii. pt. 2, p. 83, nec L.—*Ch. vulgaris*, Hag. Ent. Month. Mag. ii. p. 60.)

Madeira (*Wollaston*); near Sant' Anna, 26th November (*Eaton*).

Canaries (*Webb et Berthelot*): near Las Palmas, Grand Canary, beaten from olive, 6th December (*Eaton*); in the botanic garden, Orotava, 15th December; from pine trees near Aguamansa, 16th December; on a carob-tree at Santa Cruz, 27th December, Teneriffe (*Eaton*).

Brauer is, I believe, now quite decided in his belief that *microcephala* is only a slight variety of *vulgaris* in which some of the costal nervules at the base have a slight dark indication at their junction with the subcosta, and some of the other basal nervules are faintly blackish; the face less suffused with rosy than in the typical form, and there is a blackish streak on the sides of the cheeks and on the sides of the clypeus. Coexisting with these peculiarities I generally find the dividing nervule of the third cubital cellule interstitiate with the nervule above it.

If *microcephala* could be maintained as distinct, it is probable that the whole (or nearly so) of the Madeiran and Canarian examples should be referred thereto. In twelve examples before me (five from Madeira, seven from the Canaries) the whole of these present the slight darkening of the basal nervules indicated above. In all of them, excepting two from Madeira and one from Teneriffe, the dividing nervule of the third cubital cellule is interstitiate with the nervule above it; in only two of them—from Madeira and Teneriffe respectively—are the blackish lines on the sides of the face absent, in each case correlated with the normal third cubital cellule of *vulgaris*; in one—from Madeira—the lines on the face are present, and the third cubital cellule is normal. These conditions occurred together at the same place and under the same circumstances, indiscriminately. I think this is sufficient to prove that *microcephala* has no specific existence: the form thus termed appears to be decidedly more frequent in the south.

In Northern and Central Europe the examples found in winter or early spring are usually more or less suffused or spotted with reddish: this condition does not appear to exist in the islands, and is acquired during hibernation.

Brullé's types of *H. albus* and *H. perla* both belong here; of the latter, wings only exist.

Four examples taken by Eaton at Mazagan in Marocco, on the 7th January, are typical *vulgaris*.

This insect probably occurs in all the Atlantic islands. I have it from St. Helena. But the eggs, larvæ, or pupæ are exceedingly likely to be introduced with plants; hence it is possible it may not be strictly endemic.

CHRYSOPA FORTUNATA, n. sp.

Green, with a slight bluish tinge.

Antennæ moderately slender, dusky testaceous, darker toward the tips; basal joint very bulbose, yellowish, with an irregular blackish-brown longitudinal line above, and (sometimes) a blackish-brown dot at its apex internally. *Face* with a biarcuate blackish-brown transverse line below the antennæ, dilated on either side; clypeus broadly margined with blackish brown in its middle; a blackish-brown line on each cheek below the eyes, and a smaller one on each side of the clypeus. *Crown of head* with a narrow deeply biarcuate line above the antennæ, outlining the deep cavities in which the basal joints are inserted, forming an angle

between the basal joints (which is sometimes continued on the face as a short longitudinal line); in the middle are two parallel slightly interrupted longitudinal lines on the triangular elevated portion; and the superior orbits have a spot or band (all these markings more or less blackish brown). *Palpi* nearly black; the articulations and the apex of the terminal joint pale. *Pronotum* longer than broad, the sides nearly parallel; broadly margined on each side with blackish, forming broad lateral bands not quite complete, but more or less broken up by spots of the pale ground-colour. These marginal bands are more or less continued on each side of the *meso-* and *metanotum*, but are there much broken up into spots. *Pectus* and *pleuræ* green, more or less lined and spotted with black; pronotum wholly green.

Abdomen green, spotted with black on the sides (but arrangement not definable in dry examples).

Legs pale green, with minute black hairs; tarsi dusky; *claws simple* (not suddenly dilated internally), testaceous.

Wings moderately broad, the anterior scarcely acute at the extreme apex, the posterior more decidedly acute. In the anterior there is a conspicuous black spot near the base of the costa, another at the extreme base of the radius, another (sometimes indistinct) in the small anal area, and another (*triangular and very distinct*) near the base of the inner margin at the termination of the first postcostal nervule, which is somewhat incrassate; *all the longitudinal nervures pale*, the reticulation otherwise *wholly black*; the partition nervule of the third cubital cellule ending only slightly beyond the nervule above it; 5 nervules in the inner gradate series, 7 in the outer; short black hairs on all the reticulation; pterostigma slightly dusky. Posterior wings with a small blackish spot near the base of the costa; reticulation coloured as in the anterior.

Expanse 30–31 mm. Breadth of anterior wing 5–5½ mm.

Canaries: Santa Cruz de Las Palmas (island), 1800 feet, 29th December (*Eaton*, 2 ♀).

Amongst European species this is decidedly nearest to *Ch. Genei**,

* In Schneider's monograph *Ch. Genei* is placed in a section (p. 63) characterized by the words "Secundo antennarum articulo brunneo aut nigro colore cincto." In order to prevent misapprehension, it is necessary to state that this character is not constant in *Genei*. On the other hand, there are indications that the second joint of the antennæ may sometimes be blackish or brownish in *fortunata*. The character fails as sectional (even if applied to its most typical

Rambur, of South Italy and Sardinia, and agrees with it in the simple claws, and also in the general system of coloration, and in form. It is larger, and distinct, especially in consequence of the spots at the base of the anterior wings. It also has affinity with *Chrysopa dorsalis*, Burmeister.

Var.? Smaller. Brighter green. All the markings on the head and thorax only faintly indicated; the pronotum without dark margins, but only with sublateral obscure lines; the meso- and metanotum with obscure lateral spots. Wings with the basal spots and colour of reticulation as in the type form; reticulation open; only 3 nervules in the inner and 5 in the outer gradate series in the anterior wings; the partition nervule of the third cubital cellule interstitiate with the nervule above it.

Expanse $23\frac{1}{2}$ mm.

One ♀ taken in company with the type form. I believe this is only a dwarf pale condition of *fortunata*; but the point can hardly be decided without further materials and local observation.

CHRYSOPA SUBCOSTALIS, n. sp.

Closely allied to *C. fortunata*. Differs as follows:—The two lines on the crown of the head reduced to dots, or absent altogether. The blackish margins of the pronotum very broad, and complete (not enclosing spots of the pale ground-colour); on the meso- and metanotum they are more or less broken up into spots. In the anterior wings the subcosta is *conspicuously black* for about half its length from the base, the longitudinal nervures otherwise green; the rest of the reticulation dusky, not so decidedly blackish as in *fortunata*, and (with the exception of the costal nervules) appearing almost green in certain lights; basal spots as in *fortunata*; but that in the anal area is not indicated, and that on the first postcostal nervule is still more distinct, and the nervule itself much thickened, the spot forming a raised shining black blister; partition nervule of the third cubital cellule rather more extended; 3 nervules in the inner gradate series, and 5–6 in the

species). All that can be said in its favour is that it is *the usual* condition in a series of species that otherwise agree in general form. But in this same series we find what ought to be a far more important character in the form of the tarsal claws, represented in both conditions, and to an extent that, without consideration of it, much confusion is likely to exist (ex. gr. *Ch. abbreviata* and *phyllochroma*).

outer. In the posterior wings the subcosta occasionally presents the same colour-peculiarity as in the anterior, but not constantly so; the costal nervules conspicuously black.

[According to notes on the living insect, the eyes are metallic green. Abdomen having the spiracular line, and a series of oblique linear marks above it, black; venter green and spotless.]

Expanse 25–29 mm. Breadth of anterior wing $4\frac{1}{2}$–5 mm.

Canaries: in the botanic garden at Orotava, 15th December, on a carob-tree at Santa Cruz, 27th and 28th December, Teneriffe (*Eaton*, 5 ♀).

It may justly be suspected that *Ch. fortunata* and *subcostalis* are only insular forms one of the other, but maintaining their distinctive characters. *Ch. subcostalis* is considerably more like *dorsalis*, a resemblance heightened by the dark subcostal nervure. The black spot at the termination of the first postcostal nervule is a conspicuous character both in *fortunata* and *subcostalis*.

CHRYSOPA ATLANTICA, n. sp.

Full dark leaf-green (becoming dusky yellowish in old dry examples).

Antennæ slender, yellowish; basal joint bulbose, green like the body, with indications of a dark longitudinal line above; the second joint also indistinctly marked by a dark spot above. *Face* spotted with black as follows:—a lunate spot under each antenna, a large oval spot on each cheek, and a line on each side of the clypeus. *Labrum* reddish. *Crown of head* with a narrow biarcuate line limiting the elevated triangular portion, extended in an expanded manner between the antennæ, and forming a triangular mark in front at the summit of the face; the insertions of the antennæ indicated by a blackish transverse line. *Palpi* green, slightly marked with blackish externally; the terminal joint tipped with reddish-piceous.

Pronotum scarcely longer than broad, the sides parallel; on the disk is a blackish mark formed of lines, and indicating a triangle in which is a longitudinal line, thus  ; lateral edges with a narrow blackish line somewhat furcate in front below the eyes. *Mesonotum* with a broad transverse black band in front at the junction with the pronotum, somewhat dilated on each side; all the sutures marking the divisions of the lobes narrowly black, with a short transverse black line between the lateral lobes; on each lateral lobe are two small black spots; a dusky longitu-

dinal line on the scutellum, continuous with the black median line of the anterior lobe. *Metanotum* likewise with black lines in the sutures, and spots on the lateral lobes. *Pectus* and *pleuræ* unspotted.

Abdomen marked with black (indistinctly in the dry insect). *Legs* green, with microscopic black hairs; tarsi dusky; *claws* much dilated internally at the base, the apical portion slender and strongly curved.

Wings broad, acute and almost angulate at the extreme tips. In the anterior pair there is a small blackish line close to the base of the costa, in front of a black tubercle at the extreme base; another blackish tubercle at the extreme base of the radius; reticulation dark green, with short black hairs; most of the transverse nervules &c. marked with blackish at each end (as also in the posterior); gradate nervules wholly black, 8 in the inner, 9 in the outer series; partition nervule of the third cubital cellule ending far beyond the nervule above it: pterostigma dusky.

[In the living insect the eyes are noted as coppery-green. The abdomen is intricately marked with black, each segment having a transverse fascia angulated on each side, and a lateral line emitting from the middle a finer line directed forwards and inwards, &c.]

Expanse 32–33 mm. Breadth of anterior wing 5¾–6 mm.

Madeira (*Wollaston*, one ♀ in my collection).

Canaries: about pine trees near Aguamansa, Teneriffe, 4000 feet, 16th December (*Eaton*, one ♀).

The example given to me by Wollaston is much discoloured.

It is difficult to assign to this a position with regard to European species; perhaps in some respects it might be placed near *Ch. formosa*.

CHRYSOPA FLAVICEPS, *Brullé*. (*Hemerobius flaviceps*, Brullé, Hist. Canar. ii. pt. 2, p. 83*.)

* The following is a copy of Brullé's description:—"De la grandeur de l'*H. chrysops*, dont il se distingue, ainsi que des espèces voisines, par la couleur fauve de sa tête et du premier article de ses antennes. On distingue sur la tête deux rangées transversales de points noirs. Le prothorax est d'un vert pâle avec quelques taches noires sur les côtés, et une ligne transversale et interrompue de la même couleur. Le reste du thorax est jaune avec des taches brunes sur les côtés. L'abdomen et les pattes sont jaunes. Les antennes sont obscures, à

Brullé's type is before me, discoloured by age. From it I have drawn up the following description:—Body wholly yellowish; the head scarcely paler, but more shining. *Antennæ* wholly fuliginous (almost blackish) with the exception of the basal and second joints, which are yellow; basal joint strongly bulbose; the second almost entirely occupied by a black ring.

Face with black markings as follows:—a large oval spot between the antennæ; a broad lunate spot below the antennæ; a short thick black line on each cheek. *Crown of head* marked with black as follows:—two median spots at the apex of the inflated portion, continued externally as lines margining the antennal cavities, and almost confluent, on the sides, with the lunate spots below the antennæ; a transverse series of 6 rather large (and unconnected) spots on the posterior margin, whereof the outer, on each side, is on the orbits. *Palpi* fuscous, with pale articulations; the terminal joint almost wholly black.

Pronotum (much damaged) longer than broad, apparently considerably narrowed in front, with black markings (compare Brullé's description).

Mesonotum marked with black as follows:—two large submedian spots on the front of the anterior lobe; lateral lobes with a large blotch posteriorly, and three spots anteriorly, the posterior sutures black; scutellum without markings. *Metanotum* with a black line in the suture between it and the pronotum; lateral lobes with two small black spots, and a large irregular curved black line, which is much dilated posteriorly. *Pleuræ* with black lines on the sutures, and a black spot at the insertion of the coxæ. *Pectus* spotted with black.

Abdomen apparently without markings, excepting a black lateral line on each side; rather densely clothed with black hairs.

Legs yellow, with microscopic black hairs; tarsi dusky; *claws* much dilated internally at the base.

Wings moderately broad, scarcely acute at the extreme tips, highly iridescent. In the anterior pair there is a black line near the base of the radius; longitudinal nervures wholly pale; costal

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l'exception de leur premier article. Les ailes sont brillantes et irisées, avec les nervures en partie jaunes et en partie brunes. Les quatre ailes ont le parastigmate ou point épais très-distinct et colorié jaune-roux."

"Cette espèce doit se trouver en France, comme le témoigne un individu de la collection du Muséum, quoique sa description ne se trouve dans aucun auteur. Elle semble se rapprocher de l'*H. capitatus*, Fab."

nervules, those near the base of the wing, those between the radius and sector, and the gradate series wholly black, the others mostly only black at each end; all the neuration and the costal edge with long black hairs; 4 nervules in the inner gradate series, 7 in the outer; partition nervule of the third cubital cellule extending considerably beyond the nervule above it; pterostigma (in both pairs) long and conspicuously reddish-ochreous, more strongly defined than is usual, and extending into the subcostal area. In the posterior pair the costal, radial, and gradate nervules are black, but the others are almost wholly pale.

Expanse 32 mm. Breadth of anterior wing $5\frac{1}{2}$ mm.

I think Brullé must have been mistaken in supposing that an individual of this species had been found in France. I know of no European species in any way allied to it (perhaps the nearest is *Chrysopa formosa*, Brauer); the blackish antennæ, disposition of the black markings on head and thorax, and the strongly defined pterostigma are opposed to all European forms. Neither do I, at present, know of any closely allied extra-European species. Brullé's description is good, only not sufficiently precise. *Hemerobius capitatus*, Fab., is very different, and pertains to the genus *Nothochrysa*, M'Lach.

MYRMELEONIDÆ.

? PALPARES HISPANUS, *Hagen*. (*Myrmeleon libelluloides*, L. ?, Bory de St. Vincent, Essai, p. 369.)

Madeira (a larva in my collection).

Canaries (*Bory de St. Vincent*).

I have seen no imago of *Palpares* from the islands. A larva from Madeira in my collection (obtained from a dealer) agrees with others from Tangier in Marocco, found there with the perfect insects of *P. hispanus*, which is possibly only a marked local variety of *libelluloides*. On the other hand, it is quite possible the Canarian species may be different, and perhaps identical with one of those from West Africa. Neither Webb and Berthelot, Wollaston, nor any modern traveller has noticed the existence of this conspicuous genus in the islands.

FORMICALEO CATTA, Fab. (*Myrm. catta*, F. Syst. Ent. p. 312; Brullé, Hist. Canar. ii. pt. 2, p. 83, pl. iii. fig. 3; Hag. Ent. Month. Mag. ii. p. 61.—*M. lituratus*, Brullé, loc. cit., nec Oliv.)

Madeira (*Banks, Wollaston*).

Canaries (*Webb et Berthelot*).

Apparently the insular representative of *F. tetragrammicus*, maintaining slight distinctive features.

The type of *lituratus*, Brullé, is before me, and appears to be only a small example of *catta*, which is virtually acknowledged by Brullé; Olivier's species of same name is certainly different.

MYRMELEON ALTERNANS, *Brullé* (Hist. Canar. ii. pt. 2, p. 82, pl. iii. fig. 4; Hag. Ent. Month. Mag. ii. p. 61, redescribed).

Madeira (*Wollaston*).

Canaries (*Webb et Berthelot*).

I have not seen this species from the African continent nor from Europe, and do not think the synonymy suggested by Hagen (Ent. Month. Mag.) will hold good. Neither was my former coupling of *alternans* with *secretus*, Walker (*cf.* Journ. Linn. Soc., Zoology, ix. p. 279, and Ann. Soc. Ent. Belg. xvi. p. 138), justifiable. *M. alternans* is a broader-winged species, with more dense reticulation, the transverse nervules being faintly margined with greyish, bringing out the network very conspicuously. Brullé's type is before me.

The existence of several small species of *Myrmeleon* with the abdomen yellow-banded occasions much confusion.

MYRMELEON DISTINGUENDUS, *Rambur*. (*M. hyalinus*, Olivier??; Brullé, Hist. Canar. ii. pt. 2, p. 82, pl. iii. fig. 5.)

Canaries (*Webb et Berthelot*).

I have examined Brullé's type. *M. hyalinus*, Oliv., is an Arabian species, and its identity with the Canarian insect scarcely probable.

In the Brussels Museum and in my collection is a species collected by the late M. Camille Van Volxem, presumably in Portugal, that appears to me identical with the Canarian; both these and Brullé's types are ♂.

Furthermore I have re-examined two ♀ types of *M. distinguendus*, Ramb., from Malaga (in De Selys's collection). These are larger (expanse about 50 mm.); but otherwise they appear to me to agree; the only difference (other than size) is a slight variation in the form of the dark space on the head about the base of the antennæ, which has a triangular excision on the face in the types, not noticeable in the others; but in Rambur's description this character is given as an exception rather than as the rule.

In Brullé's type the dark markings on the head and thorax are

faint (principally owing to the age of the specimen), but are distinctly traceable.

I have a specimen from Damara Land, S.W. Africa, scarcely separable (Rambur states that *distinguendus* was known to him from Senegal); and *Myrmeleon ochroneurus*, Ramb., also from S. Africa, is clearly allied, but much larger.

As the examples from (presumably) Portugal are the most recent, I subjoin a description:—

Antennæ brownish, basal joint yellow; short and stout, the club gradually formed, broad, and much flattened. *Head* and *thorax* pale yellow. On the *head* the space surrounding the base of the antennæ is occupied by a large piceous band, descending on to the face; on the crown of the head are five raised transverse brown spots, three on the posterior margin, two on the disk, and between these latter a similar longitudinal twin-spot; two faint brownish spots on the clypeus. *Palpi* yellow; the terminal joint of the labial pair much inflated, acuminate and acute, nearly wholly shining piceous.

Pronotum with a blackish line on either side (only visible laterally); on the surface are five blackish spots, viz. four sublateral (the posterior pair oblique) and one in the middle. *Mesonotum* and *metanotum* with an irregular interrupted sublateral blackish band on either side; some of the sutures narrowly blackish; and there are two spots on the anterior lobe of the mesothorax. *Pleuræ* and *pectus* with black lines and spots.

Abdomen black, slightly clothed with short cinerous hairs; the lateral sutures and the divisions of the segments narrowly yellow; the apex nearly wholly yellow; superior appendages oblique if viewed laterally, in the form of two closely applied plates, open in front, furnished with long black hairs, and also with strong short black spines on the lower end; the inferior appendage forms a boat-shaped lobe (very concave above), not extending beyond the apex of the superior, and provided with long black hairs (♂).

Legs pale yellow, with black spines and shorter pale hairs; apex of tibiæ and of each tarsal joint blackish; first joint of tarsi equal to the second and third together, terminal joint equal to the second, third, and fourth united; spurs testaceous, shorter than the first joint; claws testaceous, slender, divaricate.

Wings narrow, hyaline, only slightly dilated in the middle, acute; reticulation wholly pale (the faintest trace of short brown spaces on the subcosta), set with short blackish hairs; ptero-

stigma scarcely indicated; the corneous knob ("pelote") at the base of the inner margin of the posterior wings (♂) large, yellow.

Length of body 19 mm. Expanse of wings 38 mm. Breadth of anterior wings $4\frac{1}{2}$ mm.

Coniopterygidæ.

Coniopteryx, sp.?

Canaries: about pine trees near Aguamansa, Teneriffe, 4000 feet, 12th December, one example, apparently ♀ (*Eaton*).

I do not, at this moment, feel satisfied that this is identical with a British species. The example has about thirty-five joints in the antennæ, and ample posterior wings; two forks in the apical neuration of both pairs of wings; expanse of wings about 8 mm.

It should be remarked that this family requires a thorough generic and specific revision, which I hope soon to effect. Included in it are several very well-marked and distinct generic groups.

Coniopteryx pulchella, n. sp.

Body fuscous, very densely clothed with the usual white waxy secretion. *Antennæ* whitish, 33-jointed. *Legs* whitish; femora at the tips fuscous, and there is sometimes an indication of a fuscous line above, especially on the posterior. *Wings* of equal form, the posterior ample, very densely covered with white secretion (so that they scarcely transmit light), but *with numerous dark-grey spots* (on which the secretion appears to be less dense), as follows: on the basal half of each wing are about 6 to 8 small spots (less on the posterior); on the apical half are about 9 large spots; all the spots are placed in the areas between the veins, and those round the apical and inner margin, between each apical sector, are very large, and triangular in outline; two forks in the apical neuration in both pairs of wings.

Expanse about 6 mm.

Canaries: Montañas de Nordeste, Teneriffe, 2300 feet, under *Erica arborea*, 26th December, 2 examples, probably ♀ (*Eaton*).

So much is it the rule for the insects of this family to be uniformly covered with white or greyish secretion, that the existence of a species in which the wings were conspicuously spotted with darker might pardonably have been doubted.

The two examples of *Coniopteryx pulchella* are in very fine condition, and are beautiful little creatures.

PSEUDO-NEUROPTERA.

TERMITIDÆ.

CALOTERMES PRÆCOX (*Wollaston*), *Hagen* (Linn. Ent. xii. p. 51, Ent. Month. Mag. ii. p. 8).

Madeira (*Heinecken*).

TERMES LUCIFUGUS, *Rossi*. (Hagen, Linn. Ent. xii. p. 174, Ent. Month. Mag. ii. p. 9.)

Madeira (*Hartung*, *Wollaston*, *Heer*, *Eaton*). Hartung says it is very common near Arrabento, 3500 feet, and near Palheiro, 2000 feet. In the former locality the winged imago appeared on the 25th April, in the latter on the 9th May. Eaton found only larvæ in November.

N.B. I can find no record of any species of Termitidæ having been observed in the Canaries, but think some must certainly occur there.

PSOCIDÆ.

PSOCUS ADUSTUS, *Hagen* (Ent. Month. Mag. ii. p. 10).

Madeira (*Wollaston*).

This and the next species form a distinct group of the genus *Psocus* (as restricted), characterized by the very elongate narrow pterostigma.

PSOCUS PERSONATUS, *Hagen* (Ent. Month. Mag. ii. p. 11).

Madeira (*Wollaston*).

Canaries: near Las Palmas, Grand Canary, on an olive-tree, 6th December; near Aguamansa, Teneriffe, on *Laurus*, 16th December (*Eaton*).

In the few examples I have seen there appears to be considerable variation in the white markings on the top of the head. Mr. Eaton notes that in fresh examples the abdomen is whitish green, with a median blackish dorsal stripe dilated on each of the hinder segments, and with a blackish blotch on each side of it in its linear anterior portion: in the ♂ the belly is pale mingled with greyish black, in the ♀ wholly pale excepting along the spiracular region and at the apex.

STENOPSOCUS CRUCIATUS, *L.*

Madeira: near the Poizo, 4100–4300 feet, on *Laurus*, 23rd November, common (*Eaton*).

A very common and generally distributed European species. Some of the Madeiran examples are in a brachypterous condition. In England this condition is most frequent in early spring (as early as February in Cornwall), and is, I think, peculiar to the ♀.

Although it is a species excessively likely to be introduced with shrubs &c., I think that, from the altitude and the conditions under which it was found, it is in all probability endemic in Madeira. Moreover the examples from this island appear to present some slight peculiarities, the body, and especially the head, being paler (almost whitish yellow), with the markings of the head less distinct, though one should see others, taken at a warmer time of year, before deciding on this point. Occasionally the body of the brachypterous form is beautifully suffused with rosy.

CÆCILIUS MARMORATUS, *Hagen.* (*Psocus marmoratus*, Hag. Ent. Month. Mag. ii. p. 9.)

Madeira (*Wollaston*).

CÆCILIUS DALII, *M'Lachlan.*

Madeira (*Wollaston*, in the British Museum, but not enumerated by Hagen): Sant' Anna, in the hotel garden, 30th November (*Eaton*).

Canaries: near Las Palmas, Grand Canary, amongst olive, 6th December (*Eaton*).

In Europe this species has only been discovered in Dorsetshire, England, amongst *Buxus* in Mr. Dale's garden, and at Florence, in Italy, amongst *Quercus ilex*.

PERIPSOCUS ALBOGUTTATUS, *Dalman.* (*Psocus pupillatus*, Dale, Hagen, Ent. Month. Mag. ii. p. 9.)

Madeira (*Wollaston*, 1 example).

I have some suspicion that two species are mixed under this name, but have not completed my observations. In England I find what appear to be two forms. One of these is common amongst pine and other trees, and is larger and paler, with the markings on the wings less distinct than in the other, which I find amongst *Calluna vulgaris*. The Madeiran example seems to pertain to this latter form.

Yet another species of this family, from Madeira, probably exists in Mr. Wollaston's collection in the British Museum; but it is not in a condition for minute examination, principally owing to its having been gummed on card, a practice to which Mr. Wollaston was so particularly attached.

EPHEMERIDÆ.

CLOËON DIPTERUM, *L.* (*Cloë diptera*, Hag. Ent. Month. Mag. ii. p. 25.—*Cloëon dipterum*, Eaton, Tr. Ent. Soc. Lond. 1871, p. 102.)

Madeira (*Wollaston*, *Eaton*).

Canaries: Teneriffe (*Eaton*).

Frequents the pools formed by the streams at their lower portions, and adjacent localities where the water is warm.

BAËTIS RHODANI, *Pictet.* (*Cloë maderensis*, Hag. Ent. Month. Mag. ii. p. 25.—*B. rhodani*, Eaton, Tr. Ent. Soc. Lond. 1871, p. 114.)

Madeira (*Wollaston*, *Eaton*).

Canaries: Grand Canary and Teneriffe (*Eaton*).

Frequents cool streams up to 3000 feet, or more.

N.B. I think it may be safely assumed that no other Ephemeridæ inhabit the islands. The acquisition of the subaquatic stages of insects of this family was above every other entomological consideration with Mr. Eaton during his visit, and no larva or nymph pertaining to other than these two species was discovered. Both are notorious for wide distribution.

ODONATA.

I am indebted to my friend Baron de Selys-Longchamps for having examined some Dragonflies concerning which I was uncertain, and for the loan of a series of examples bearing upon the identification of the species found in the islands.

Libellulina.

PALPOPLEURA MARGINATA, *Fab.* (*Libellula variegata*, F., Bory de St. Vincent, Essai, p. 369.—*L. Lucia*, Drury, ♀.)

Canaries (*Bory de St. Vincent*).

I have not seen this common African species from the islands; possibly it occasionally flies over from the mainland.

SYMPETRUM STRIOLATUM, *Charp.* (*Libellula striolata*, Hag. Ent. Month. Mag. ii. p. 27.—*L. vulgata*, Brullé, Hist. Canar. ii. pt. 2, p. 82.)

Madeira (*Wollaston*, several examples; *Eaton*, 1 very adult ♀, 23rd December).

Canaries (*Webb et Berthelot*; but there is a possibility that the next species was intended by Brullé).

Although I use the name *striolatum*, it is now, I think, generally believed that the species so termed and the *vulgata* of Linné are not separable.

SYMPETRUM FONSCOLOMBII, *Selys.* (*Libellula rubella*, Hag. Ent. Month. Mag. ii. p. 26, nec Brullé.)

Madeira (*Wollaston*).

Canaries: near Las Palmas, Grand Canary, 6th December (*Eaton*, 3 ♀).

A widely distributed species, which (notwithstanding its occasional appearance in England) must be regarded as pertaining to the Mediterranean fauna.

ORTHETRUM (?) CHRYSOSTIGMA, *Burm.* (*Libellula Olympia*, Brullé, Hist. Canar. ii. pt. 2, p. 82, nec Fonsc.—*L. chrysostigma*, Burm. Handbuch, p. 857.)

Canaries: Teneriffe (according to Burmeister; ♂ ♀ in the British Museum, *Wollaston* [the ♂ indicated as received from *Heer*]; Montañas de Nordeste, 26th December, *Eaton*, 1 very adult ♂.)

This insect has occasioned great perplexity with me, and has necessitated an extended review of *Libellula trinacria*, Selys, *L. barbara*, Selys, and allied forms, in which I have been aided by the temporary possession of materials communicated by Baron de Selys. I have also been able to examine the (now mutilated) ♀ type of *Olympia*, Brullé, which is certainly distinct from Boyer de Fonscolombe's French insect (=*cærulescens*, Fab.) of that name. Not only specific, but also generic perplexity has been the result.

It has been considered probable that *chrysostigma*, Burm., might be identical with *trinacria*, Selys, which, if well founded, would necessitate the deposition of the latter name as a synonym. *Libellula trinacria* has been referred to the genus *Lepthemis*, Hagen, which is especially characterized by the much inflated base of the abdomen *in both sexes.* The type of *Lepthemis* is the

American *Libellula vesiculosa*, Fab., and other *American* insects agree therewith in points of generic structure; but the Old-World species associated with them are divergent in several points (yet agree in having the base of the abdomen inflated *in both sexes*); and on a minute revision (a thing hoped for!) of the subfamily Libellulina they would have to be separated from their American allies. Let us now turn to a familiar group of Old-World forms, of which the British *L. cancellata*, L., and *cærulescens*, Fab., may be considered typical,—forms for which Newman, in 1833, proposed the generic term *Orthetrum* (= *Libella*, Brauer, 1868, a name otherwise inadmissible, because Selys had previously used it, and in Odonata). In the more typical forms of *Orthetrum*, neither ♂ nor ♀ has the base of the abdomen conspicuously dilated in comparison with the rest. But when we come to *Libellula barbara*, Selys, (and some others,) we are concerned with an insect the very adult male of which, in a thoroughly blue-pulverulent condition, is difficult to separate from *L. trinacria* in a similar condition, but in which the ♀ has the base of the abdomen in no way dilated. Therefore I should be disposed to consider *L. barbara* an *Orthetrum*, and to place *L. trinacria* (and immediate allies) in a distinct group (on account of the female characters), more related to *Orthetrum* than to *Lepthemis* typically.

Now, as to the *specific* question involved in the Canarian *L. chrysostigma*. The materials examined by me are as follows:—(1) The mutilated ♀ type of *Olympia*, Brullé (remarkable for the presence of only two rows of discoidal areoles in the anterior wings for the greater part, an accidental condition, of which traces are frequently discernible in other species of the group); (2) the semiadult ♂ and very immature ♀ in the collection of the British Museum; (3) the very adult ♂ captured by Eaton, in my collection. The two females and the semiadult ♂ prove incontestably that *chrysostigma* is not conspecific with *trinacria*. But they show very close connection with *barbara*, yet are larger (about as large as small examples of *trinacria*); and, at this moment, the *size* is almost the only tangible point of difference apparent; for I fail to appreciate any striking differences in the genitalia of the second segment in the ♂, or in the vulvar scale (insufficiently examined on account of condition) of the ♀. From *trinacria* the immature or semiadult ♂ of *chrysostigma* (and also of *barbara*) may be at once separated by the thoracic markings (combined with the much smaller pterostigma); from highly adult

♂ of *trinacria* (wholly blue-pulverulent) the same sex of *chrysostigma* (and also of *barbara*) may be separated by the presence of a *small yellow marking at the base of the posterior wing margining he membranule.*

I have entered at length into this subject on account of the difficult points involved. The summing-up is as follows:—(1) *Libellula trinacria* (and therefore *L. Sabina*, &c.) is not a true *Lepthemis*, but is more allied to *Orthetrum*; (2) *L. chrysostigma* is not identical with *trinacria*, but is very closely allied to *barbara* (? distinct therefrom*, *cf.* Hagen, Ent. Month. Mag. ii. p. 27), and is probably not to be generically separated from *Orthetrum*.

?? PLATETRUM DEPRESSUM, *L.* (*Libellula depressa*, L. ?, Bory de St. Vincent, Essai, p. 369.)

I regard this avowedly doubtful identification as erroneous; but in a synopsis such as this the citation should not be lost sight of.

TRITHEMIS ARTERIOSA, *Burmeister*. (*Libellula distincta*, Ramb. —*L. rubella*, Brullé, Hist. Canar. ii. pt. 2, p. 82.)

Canaries (*Webb et Berthelot*); Montañas de Nordeste, Teneriffe, 26th December (*Eaton*, 1 ♂ and 2 ♀, all very adult).

A widely distributed African species. Hagen referred *rubella* of Brullé to *Fonscolombii*, Selys, but certainly in error. The detailed description given by Brullé suits *arteriosa* admirably; and the identification therewith is confirmed by the much damaged ♂ type in the Paris Museum. A question of priority might be raised as regards the names *arteriosa* and *rubella*. The former was published in 1839; the volume of Zoology in Webb and Berthelot's work bears the dates 1836–44. Although this work was published in Paris, it is certain that Rambur was not aware of its existence (or, at any rate, of the portion treating on Neuroptera) when his own volume in the 'Suites à Buffon' appeared in 1842; and Burmeister's description had been published at least three

* The types of *chrysostigma* ("♂ ♀ *in cop. capt.*") are in the possession of Dr. Hagen; and while this paper was being printed I received information from him to the effect that he considers them certainly identical with *barbara* (the former name having priority). He calls my attention to a supplementary note in the 'Revue des Odonates,' p. 398, as to an example of *barbara* from the south of Spain, said to exist in the Museum of the Jardin des Plantes at Paris, so that the species may therefore be considered European. I am not aware of any recent confirmation of this.

years previously. Rambur applied the name *arteriosa* as a doubtful synonym of *hæmatina*, which latter seems to have been a somewhat collective name, but not including the species under consideration.

The adult ♀ (so determined by De Selys) bears but little resemblance to the male. I am not aware that this sex has been described. The front is pale olivaceous; the side lobes of the labium rather distinctly margined with blackish on their contiguous edges. Thorax olivaceous, with an appearance of darker humeral lines, each side with three distinct black lines; pectus blackish, with three yellowish spots (as in the ♂), somewhat pulverulent. Legs black; tibiæ brownish externally; femora yellowish at the base, this colour more extended internally. Abdomen considerably shorter than in the ♂ (23 mm. as against 26 mm.), olivaceous, glaucous pulverulent beneath, the black lateral markings as in the ♂, but more extended; vulvar scale triangular. Wings hyaline; the anterior scarcely tinged with yellow at the extreme base; two very small yellow spots at the base of the posterior; pterostigma reddish brown; neuration brownish black, some of the costal and subcostal nervules paler; 11–12 antecubital nervules in the anterior.

CROCOTHEMIS ERYTHRÆA, *Brullé*. (*Libellula ferruginea*, Brullé, Hist. Canar. ii. pt. 2, p. 82.—*L. rubicunda*, Bory de St. Vincent, Essai, p. 362, nec L.).

Canaries (*Bory de St. Vincent, Webb et Berthelot*); Orotava, Teneriffe, about 1650 feet, December 16th (*Eaton*).

Eaton remarks that this handsome insect breeds in the reservoirs. The ♂ examples taken by him are very adult, and are slightly larger than those in my collection from various parts of the south of Europe, Africa, India, &c.

I incline to refer here an immature ♀ from near Las Palmas, Grand Canary, 6th December (*Eaton*), although De Selys expresses himself doubtful; the pale and dark humeral lines on the thorax of this example are very distinct *.

* Brullé says:—"Parmi les Libellules des Canaries se trouvent les deux sexes d'une jolie variété de cette espèce, dont la collection du Muséum renferme plusieurs individus provenant des Indes Orientales. Elle est d'un jaune roux, les côtés et le dessous de son corselet plus pâles, et chaque côté du corselet présente une bande brune étendue depuis l'origine de l'aile jusqu'au bord antérieur et bordée intérieurement d'une ligne d'un jaune clair." Probably the same form.

The *erythræa* group is one of extreme difficulty. It is probable that a solution may be found in the form of the genital parts of the second segment in the ♂; but it should be remarked that I find slight variation in this respect in series of individuals from the same locality, even in three ♂ before me from Orotava. De Selys has kindly lent me, for comparison, the types of *ferrugaria* (which he considers a synonym of *sanguinolenta*, Burmeister) and *inquinata*, Rambur. The ♂ of the former would seem to have the abdomen less broad, and with very considerable difference in the genitals of the second segment; but these latter are probably distorted. As for *inquinata*, the type is a ♀, and colour appears to be the principal character, the wings being more broadly yellow at the base, which colour is continued along the costal margin as far as the pterostigma.

Gomphina.

GOMPHUS, sp.?

Madeira (*Hartung*).

Hagen (Ent. Month. Mag. ii. p. 27) says a species from Madeira is in the collection of Prof. Heer, but he had not seen it; he suggests that it is possibly *G. simillimus*, Selys. Probably it is the same species to which De Selys refers under *Gomphus Lucasii* in the 'Monographie des Gomphines,' p. 138.

Æschnina.

ANAX FORMOSUS, *Van der Linden.* (*Æschna formosa*, Brullé, Hist. Canar. ii. pt. 2, p. 82.—*A. formosus*, Hag. Ent. Month. Mag. ii. p. 27.)

Madeira (*Wollaston*, &c.).

Canaries (*Webb et Berthelot*, &c.); Tafira, 1500 feet, 8th December, and near Palmas, 10th December, Grand Canary (*Eaton*); Santa Cruz de Teneriffe, 28th December (*Eaton*).

In all probability this is the large Dragonfly referred to by most writers who have mentioned the insects of the islands; and I think it is a true native. Hagen (Ent. Month. Mag. *l. c.*) suggests that it may have been introduced with eggs of *Rana esculenta* in the same manner as there appears to be some reason to believe it was introduced into Sweden (*cf.* Hagen, Revue des Odonates, p. 394). But there is no necessity to suppose accidental or intentional introduction; an insect of such great power of wing could easily pass over from the mainland, or *vice versâ*. I do not find any

tangible differences in the examples from the islands, as compared with others from Europe &c. A ♂ in De Selys's collection certainly seems to have the superior appendages more attenuate at the apex; but I think it is owing to the turn they have taken in drying, and hence illusory.

? Anax mauricianus, *Rambur*.

Madeira.

I possess one ♂ *Anax* obtained from a dealer, and indicated from Madeira, that is probably referable to *mauricianus*; other insects accompanying it were certainly Madeiran.

Hagen (Verh. z.-b. Gesellsch. Wien, xvii. p. 44) doubts the distinctness of *mauricianus* from *formosus*; possibly it is only a case of slight variation; still there are certain structural peculiarities. Rambur, in describing his *mauricianus* (Névroptères, p. 184), alludes to several colour-differences that are probably illusory for the greater part. As to structure, he mentions, *inter alia*, the following points:—"Abdomen plus long, plus grêle;" superior appendages internally "plus profondément sinueux en approchant de l'extrémité, qui est plus étroite;" inferior appendage "un peu plus court;" "pterostigma beaucoup plus petit;" also "nervure costale chez le mâle n'etait pas jaune antérieurement." In all these points my example fully agrees; but in some others—such, for instance, as the absence of little tubercles on the margin of the tenth segment—it does not accord. De Selys has kindly lent me a series of examples bearing upon the question, including one of Rambur's types from Mauritius *. This agrees with the description in most of the points mentioned, but disagrees in others (as does my example). The costal nervure is yellow externally in this, black in mine (I do not think I have seen a true *formosus* in which this nervure is black externally; but it may occur in very adult examples). The inferior appendage is still shorter in mine, scarcely longer than broad; in this it appears to agree with examples from De Selys, labelled by him "*mauricianus*, race *brevistigma*," received from Madagascar and Bourbon; and even the pterostigma in my example more approaches these. Probably it would be safer to refer *formosus*, *mauricianus*, and its race *brevistigma*, all to one species (*formosus*); but we yet require more extended local information †.

* Probably other types are in the Oxford Museum; but that in De Selys's collection should be from the same source, *i. e.* "M. Marchal."

† Hagen (Verh. z.-b. Gesellsch. Wien) alludes to the condition of the median

Anax Parthenope, *Selys*.

Canaries: Teneriffe (according to Brauer, Reise der 'Novara,' *Neuroptera*, p. 61). Not seen by me from the islands.

Cyrtosoma ephippigerum, *Burmeister*.

Canaries.

Hagen (Verh. z.-b. Gesellsch. Wien, xvii. p. 31) says he possesses an example indicated "im atlantischen Meere drei Meilen * von den canarischen Inseln, von Afrika kommend gefangen." This is a well-known migratory species, which occasionally appears on the European shores of the Mediterranean in great numbers, though I think there is as yet no evidence that it breeds in Europe. I have an example indicated as found on the shore at Mogador during a storm in January.

This species may safely be given as Canarian on the evidence of Hagen's specimen.

Agrionina.

Ischnura pumilio, *Charpentier*. (*Agrion pumilio*, Ramb. Névrop. p. 277; Selys, Revue des Odonates, p. 182; Hag. Ent. Month. Mag. ii. p. 27.—*I. pumilio*, Selys, Synops. Agrion., Légion 5, p. 23.)

Madeira (according to Rambur, in Selys's collection; *Wollaston*); near Funchal, 20th November (*Eaton*).

All the females that I have seen from Madeira pertain to the dimorphic orange-coloured condition.

Ischnura senegalensis, *Rambur*.

Madeira.

My knowledge of this African species as Madeiran is based solely on 1 ♂ and 1 ♀ in De Selys's collection. The ♂ is from Rambur's collection, and is labelled by him "*Agrion maderæ*," an unpublished name; it is in bad condition, but is certified as *senegalensis* by De Selys.

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suture ("Quergräte") of the second segment of *formosus*, so far as the angle formed by it in its middle is concerned; I find all intermediate conditions in the long series before me, independent of locality.

* *German* miles must be understood.

New Entozoon from the Ostrich.

By T. SPENCER COBBOLD, M.D., F.R.S., F.L.S.

[Read November 17, 1881.]

[PLATE IV.]

ON the 23rd of March 1880 I received from South Africa two bottles, the larger one containing part of the proventriculus of a young Ostrich preserved in spirit, and the smaller one a quantity of loose vegetable débris, in which were several Nematode worms. These were sent by Mr. Arthur Douglass, of Heatherton Towers, near Grahamstown; and, by letter, I was informed that the bird yielding the parasites had not died in consequence of the disease from which it was actually suffering, but had been purposely destroyed on account of a broken leg.

Speaking of the proventriculus as the "paunch corresponding with the crop of other birds," Mr. Douglass says to me in his letter:—"You will find vast numbers of small Entozoa in the mucus. A medical gentleman who examined them believes them to be a totally unknown worm." Mr. Douglass's statement and his friend's inference are correct. The parasite represents a new species; and in my reply to the discoverer, I provisionally named it *Strongylus Douglassii*. Judging from the materials sent, the number of parasites in this bird must have amounted to several thousand.

For diagnosis I give the following characters:—

STRONGYLUS DOUGLASSII, sp. nov.—*Body* smooth, transversely striated, nearly uniform in thickness, rather suddenly narrowed in front; *head* minute, often spirally folded inwards; *mouth* simple, unarmed; *œsophagus* long, gradually thickening below; *tail of the male* with a broad, two-lobed hood and simple ray-arrangement; *spicules* short, stout, closely applied; *tail of the female* directed inwards, suddenly narrowing below the *anus*, which is subterminal.

Length of male $\frac{1}{6}$ inch, breadth about $\frac{1}{240}$ of an inch.
Length of female $\frac{1}{5}$ inch, breadth about $\frac{1}{215}$ of an inch.
Hab. Proventriculus of *Struthio camelus*.

The transparency of the body enables one to ascertain the general structure of this little nematode without dissection. The mouth and intestinal tract offer no marked peculiarity; but in many of the preserved specimens the integuments about the head are so inflated by endosmosis that they are frequently inverted.

From this cause an inexperienced observer might readily mistake the cup-shaped inverted portion for the lining membrane of a large buccal cavity. The oral opening leads to a small œsophageal tube, which for a short distance is strengthened by chitinous thickening. The head itself is something less than $\frac{1}{1000}$ inch in breadth, the extremity of the tail in the female being less than $\frac{1}{1500}$ inch in diameter.

The internal reproductive organs of the male show a simple vas deferens or tubal prolongation from the seminal receptacle; but the short, broad, and uncleft spicules are to some extent characteristic of the species. They present an average length of $\frac{1}{220}$ inch by $\frac{1}{770}$ inch in breadth.

The accessory appendages are especially noteworthy. In general configuration and ray-distribution, the hood approaches the pattern found in *Strongylus ventricosus*; but this latter strongyle is very much larger. In breadth the hood of *Strongylus Douglassii* measures $\frac{1}{115}$ inch, whilst its vertical diameter is about $\frac{1}{220}$ inch. In this species the anterior ray is split into two widely diverging branches, the lower being paramount. A similar peculiarity is found in the anterior ray of *S. ventricosus* of the ox and deer, in *S. nodularis* of ducks and geese, and in *S. retortæformis* of the hare; at least Schneider has so represented the character of the anterior ray in these species. In *S. Douglassii* both the ray-divisions are papillated at their points; but I did not notice papillary terminations in any of the succeeding rays. The thumb-and-finger-like appearance of these upper ray-divisions is very striking. The antero-lateral ray is comparatively large. The middle ray is divided to the base, its portions being nearly equal. The postero-lateral ray is narrow, and does not extend to the border of the hood. The posterior ray is united to its fellow of the opposite side; it is long and narrow, bifurcated at the lower third, the inner branch being also forked. All the divisions of the posterior ray extend to the circumferential margin of the hood, which at this (the lowermost) point slightly projects, as if forming a rudimentary third lobe. The hood-membrane itself displays the usual radiating striæ, bespeaking its integumentary origin; and above it the ventral surface of the body is marked by several undulating lines or ridges directed obliquely outwards.

The internal reproductive organs of the female worm, while conforming to the nematode type generally, show the uterine and ovarian portions very distinctly. The vulva is situated $\frac{1}{15}$ inch

above the point of the tail. The narrow cæcal end of the upper ovary passes into the superior third of the body, and usually folds upon itself once or twice. The lower uterine horn, after passing downwards to very near the anus, suddenly bends upward, and terminates in a narrow ovarian cæcum, which occupies a position corresponding with that of the tubal portion of the superior uterine horn. The most striking feature, however, is that which relates to the small number and comparatively large size of the eggs. Roughly, their separate measurement averages $\frac{1}{180}$ inch in length by $\frac{1}{750}$ inch in breadth. The more perfect eggs contain incompletely formed embryos. As hitherto we have been accustomed to find the Strongyles supporting a very large number of ova, this paucity of eggs is, so far as my experience goes, altogether peculiar. Amongst the free Nematodes one constantly encounters females with only one, two, or several perfect ova; but I know of no Strongyle carrying so few as twenty to thirty eggs; yet that peculiarity obtains in this Strongyle from the Ostrich. When, recently, Dr. Örley, the Hungarian helminthologist, visited this country, I had an opportunity of showing him *S. Douglassii* under the microscope. He at once recognized the exceptional character of this phenomenon.

Practical Considerations.—Some useful and interesting particulars are related in the communication received from Mr. Douglass. The victimized bird was 18 months old, being one of a flock. On opening it, the worms, he says, "were all alive, although the flock had had salt with their food daily for a month, and a week before one ounce of sulphur each." My informant's surprise was not unnatural, seeing that agriculturists have long appreciated the value of salt and sulphur as a prophylactic and parasiticide. Many years ago Professor Simonds conducted a simple experiment, which showed that salines proved fatal to a worm infesting the stomach of a lamb. He called the parasite *Filaria hamata*; but I subsequently identified it with *Strongylus contortus* of Rudolphi. Mr. Douglass says that he first discovered these Ostrich-Entozoa in December 1879, "when a flock of 200 Ostriches, running in a camp of 4000 acres, suddenly fell off in condition, and three died." He examined the dead birds, and adds :—"I found the mucus of about half the paunch to have acquired a fungus growth of an inch or more in length, under which the paunch was red with millions of these worms. Shortly after, three more of the flock were worried to death by dogs, and they were all affected [by the parasite]. From the appearance of the others, I knew the whole to be so; and from reports of the mortality in birds from all parts of South Africa, I believe the disease to be general."

From experiences long ago gathered by myself in the investigation of Grouse and Pigeon epidemics, respectively, and from what I have also discovered to obtain in the case of certain animal epidemics not hitherto judged to be of parasitic origin, I was in no way surprised at this announcement of a new avian epizoöty due to parasitism. All the helminthic outbreaks present certain features in common. As fatal epidemics or plagues they come and go; and although the parasites that cause them are never really altogether absent, the evil results of invasion are only manifested and recorded when the parasites are sufficiently numerous to make their presence felt—that is, epidemiologically speaking. All epizootics of this character are immediately due to excessive multiplication of worms, the unusual prevalence being itself due to exceptionally favourable conditions.

When the Grouse-disease prevailed, alarmists predicted that these valuable game-birds would soon share the fate of the Dodo; yet, as I pointed out at the time, this conclusion was based upon an entire misunderstanding as to the nature of the disorder. If it could not be shown that the Grouse epidemics of former years were due to parasitism, I at least demonstrated that the outbreak of 1872–73 was principally caused by a Nematode not then known to science. This worm I named *Strongylus pergracilis* *. Upwards of thirty Grouse were examined by me during the epidemic, most of the diseased birds having been either captured alive or shot on the Earl of Cawdor's moors. The Grouse and Ostrich Strongyles bear a considerable resemblance to one another; but the Grouse worms are much longer and otherwise differ. Not improbably the mode of development is similar, both requiring a change of hosts. Be that as it may, and in absence of special researches upon this point, I may observe that the method of dealing with the Ostrich epidemic was in the right direction. Had the salines been combined with lime-water, I think the treatment would have proved more or less effective. What is really wanted is some drug that is known to exert a special action on Nematode worms without injuriously affecting the host. It seems to me that the so-called milk of Papaw (*Carica papaya*) is likely to answer the purpose. The remarkable properties of the active principle of this drug (as made known by M. Wurtz, and referred to at a former Meeting of this Society) would at once suggest the use of Papaw in any form of nematelminthiasis; and the practical efficiency of the drug as an oxyurifuge has been attested by Dr. Peckolt †. Several years ago Dr. Marcet showed that the perivisceral fluid of the larger Nematodes closely corresponded with the ordinary juice of flesh; and without doubt this fluid is mainly concerned in sustaining the life of the worms ‡. Since, therefore, Papaine possesses the power of

* 'The Grouse Disease; a statement of facts tending to prove the parasitic origin of the epidemic.' 'The Field' Office, London, 1873.

† Pharmaceutical Journal, vol. x. See also Mr. Christy's 'New Commercial Plants and Drugs,' No. iv. p. 38: London, 1881.

‡ Proceedings of the Royal Society, vol. xiv. p. 69 (1861).

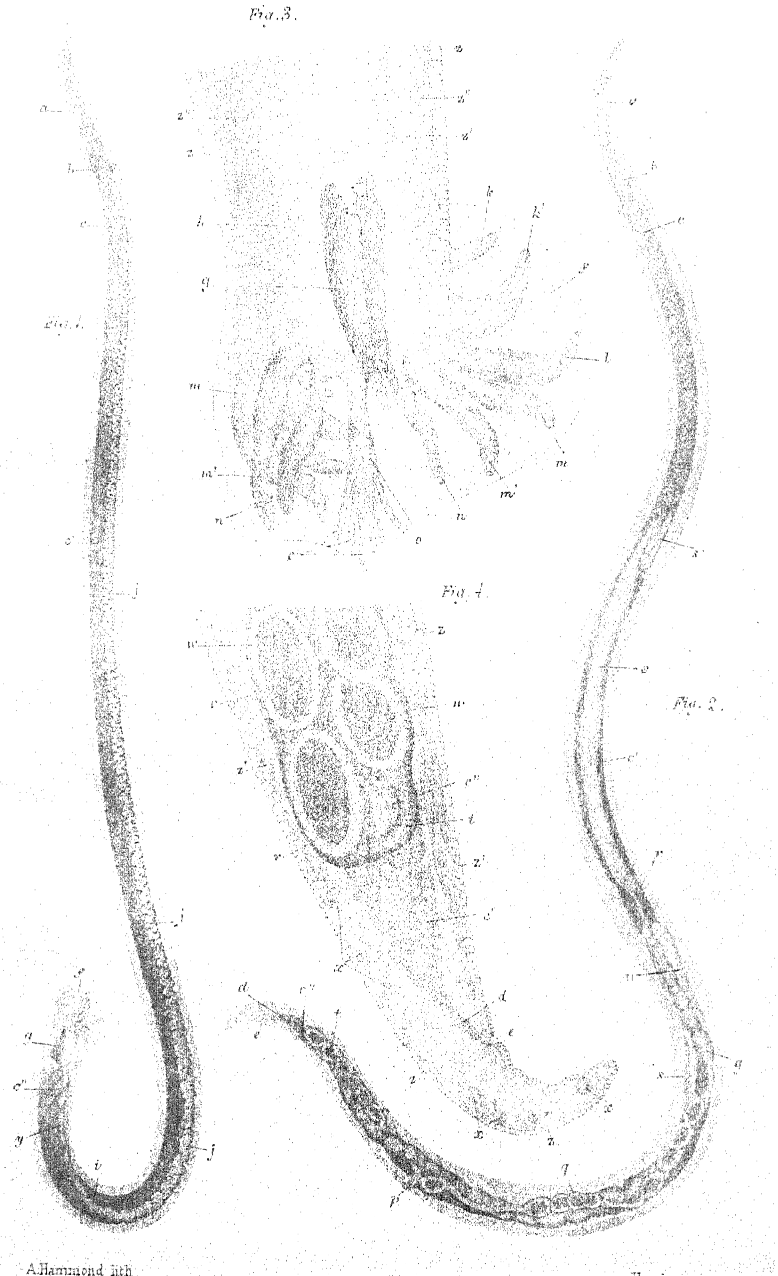
dissolving fibrine, it is likely that its absorption by endosmose when brought into contact with the worms would destroy them. It is not probable that any difference of action would result by employing the drug for the destruction alike of Strongyles, Ascarides, Oxyurides, or even Filariæ. I would strongly advise the Ostrich-farmers to give Pawpaw a fair trial. To some it will naturally occur to recommend santonine; but seeing how injuriously this agent has acted upon puppies, and also how ineffective for good it has proved in our hands in cases of Oxyurides, its employment in young Ostriches seems contra-indicated.

But there is another practical phase of this question of great interest. It appears to me that these epidemics form, as it were, by-way phenomena of the "struggle for existence." In this view they are most instructive. This Ostrich epizoöty is a kind of *strongylosis*; and as such it has its counterpart in the *trichinosis* of swine, in the *olulanosis* of cats, in the *filariasis* of man, and so forth—all these disorders representing so many special forms of *helminthiasis*. In every case we see a multitude of liliputian creatures battling for their own existence. The war is carried on at the expense of the victims infested; and when, as in the instance before us, the parasites become abnormally prodigious in number, then the bearer or victim is injured. In other words, the invaded territory suffers from overcrowding and multiplied wounds. Of course, amongst avian, as also among mammalian victims, the smaller and younger hosts suffer more readily than adults. Thus lambs perish more quickly than sheep, colts than horses, chicks than their parent birds. In extreme cases no animal, whatever its size or age, can long withstand the assaults of certain kinds of internal parasites, armed as they not unfrequently are with boring weapons. Thus also, as has been recently shown in my paper on the parasites of Elephants, comparatively small Entozoa are often as effective for mischief as the larger species.

DESCRIPTION OF PLATE IV.

Figs. 1 & 2. Male and female *Strongylus Douglassii*. × 65 diameters.
3 & 4. Caudal extremities of the same. × 260 diam.

a, head; *b*, œsophagus; *c*, chylous intestine, *c'*, middle, and *c''*, lower ends of the same; *d*, rectum; *e*, anus; *f*, hood and rays of the male; *g*, spicules; *h*, sheath; *i*, vas deferens; *j*, testis; *k*, *k'*, anterior ray-divisions; *l*, antero-lateral ray; *m*, *m'*, middle ray-divisions; *n*, posterior lateral ray; *o*, posterior ray of the right lobe; *o'*, branches of the posterior ray of the left lobe; *p*, vulva of the female; *q*, upper uterine horn; *r*, tuba; *s*, ovarium, and *s'*, upper ovarian cæcum; *t*, fold of lower uterine horn; *u*, cæcal end of the lower ovarium; *v*, ovum; *w*, embryo; *x*, caudal papillæ of the female; *y*, oblique skin-folds of the male; *z*, transverse cutaneous striæ; *z'*, longitudinal muscle-cells; *z''*, retractor muscle of the sheath of the male spicule.



A. Hammond lith. Hanhart imp.

STRONGYLUS DOUGLASSII. Cobb.

The Asteroidea of H.M.S. 'Challenger' Expedition.—Part I.

By W. Percy Sladen, F.L.S., F.G.S.

[Read January 19, 1882.]

[Published by permission of the Lords Commissioners of the Treasury.]

Part I. PTERASTERIDÆ.

The Asteroidea collected during the expedition of H.M.S. 'Challenger' were kindly intrusted to my care by Sir C. Wyville Thomson in the early part of the past year (1881), to report upon and describe. As might naturally be expected in a group of animals of such universal occurrence, the amount of material is very great, and furnishes additions of the highest importance to our knowledge of the geographical and bathymetrical distribution of species, of variations of form within areas of occurrence, and of growth-stages; whilst the number of species new to science is also very considerable. These circumstances, together with the fact that comparatively little has hitherto been known respecting the Asterid fauna of abyssal depths, are sufficient to indicate the interesting and important character of the collection under notice.

It is my intention to lay before this Society an account of the species obtained, with descriptions where necessary, and to present the same by instalments during the course of the preparation of the detailed Report, which will ultimately form a part of the Official Report of the Voyage now in process of publication. In the issue of the proposed preliminary lists I shall not feel called upon to adhere rigidly to the sequence in which families or genera are classified by systematists. The parts will more probably be issued as soon as my examination of special groups is completed; and this, for obvious reasons, will be determined in a great measure by conveniences of study and comparison. By this means I hope to be able to lay more speedily before specialists an outline of the results of the Expedition as far as the Asteroidea are concerned, and thus render them available for general consultation and reference. All questions of anatomy, development, variations, and general deductions will be reserved for the Report above mentioned.

Fam. PTERASTERIDÆ.

Synopsis of Genera included therein.

Ambulacral spines forming transverse combs. Spines united by web.	Supradorsal membrane with muscular fibrous bands. Actino-lateral spines forming a free independent lateral fringe; not merged in the actinal floor.	Muscular bands not reticulated. Membrane usually containing spicules.	PTERASTER.
		Muscular bands regularly reticulated. No spicules in membrane.	RETASTER.
	No muscular fibrous bands in the supradorsal membrane. Actino-lateral spines merged in the actinal floor. No lateral fringe.	Paxillæ-spinelets (15–30), long and hair-like, protruding freely through the membrane. Ambulacral spines part horizontal. 1 pair of secondary mouth-spines; united by web to mouth-spine series.	MARSIPASTER.
		Paxillæ-spinelets (5 or 6) short, robust, not protruding. Ambulacral spines perpendicular. 3 pairs of secondary mouth-spines, free and independent.	CALYPTRASTER.
Ambulacral spines not forming transverse combs. Spines independent, and not united by web.	Nidamental cavity spacious. Supradorsal membrane well-developed. Muscular fibres present. Spiracula present. Spinelets of paxillæ short, not protruding through, but supporting, the membrane.		HYMENASTER.
	Nidamental cavity aborted. Supradorsal membrane rudimentary. No muscular fibres. No spiracula. Spinelets of paxillæ fascicular, protruding a great portion of their length naked through the membrane.		BENTHASTER.

Hitherto this family has been represented by a very limited number of forms, only nine species being on record. Eight of these belonged to the genera *Pteraster* and *Retaster*; and the ninth was the type and solitary representative of *Hymenaster*, a genus established by Sir Wyville Thomson for a remarkable Asterid discovered during the cruise of H.M.S. 'Porcupine.'

Thirty-four species of Pterasteridæ have been obtained by the 'Challenger,' only two of which were previously known. Of the thirty-two new species, three belong to *Pteraster*, four to *Retaster*, and the remarkable number of twenty to *Hymenaster*, a genus which is now found to possess a world-wide distribution in deep waters. The remaining five species are representatives of

three new genera, viz.:—*Marsipaster*, two species; *Benthaster*, two; and *Calyptraster*, one.

Note on Terminology.—For the sake of brevity and to avoid verbose repetition, several terms are employed in the following descriptions which have not previously been used in their present special signification. The introduction of these terms is necessitated by structural peculiarities in the forms comprised in the family Pterasteridæ, several of which have hitherto been unobserved, whilst others have been ignored or passed over by previous systematists. The application of the terms will, in most cases, be self-evident. The following is a brief definition.

The *supradorsal membrane* is the veil-like covering or external independent tissue whereby the dorsal nidamental cavity is formed. The membrane is supported above the true dorsal surface of the animal by the *paxillæ*, which consist of a long columnar pedicel surmounted by a "crown" of fine, more or less elongate spinelets. In the majority of forms belonging to this family, fine muscular fibrous bands extend between the tips of the spinelets, and constitute a more or less regular fibrous network; and the general tissue of the dorsal membrane which fills in the interspaces or meshes is usually perforated by small contractile pores, styled *spiracula* by Sars. A large aperture occurs in the supradorsal membrane, situated over the centre of the disk and opening directly into the dorsal cavity, to which it affords the common means of ingress and egress; it is named the *oscular orifice.* This aperture may be closed by five more or less regular fan-like valves, or simply by a number of webbed or papillose spinelets. A number of small apertures open into the nidamental cavity on the actinal surface of the Starfish, an aperture being situated at the base of each of the long actino-lateral spines and close up to the adambulacral plate. There is consequently an opening into the cavity on either side of the furrow corresponding with each segment of the ray; hence these are spoken of as *segmental apertures.* The openings are guarded, and can be closed, by a small spinelet or papilla articulated on the adambulacral plate, and termed the *aperture-papilla.* In some genera these appendages are partially hidden in the actinal membrane, and are free on one side only; in others they are perfectly free, and covered with a more or less expansive investing membrane of their own. The long spines articulated on the body-frame close to the adambulacral plates, and which form the lateral or marginal web in

Pteraster, and support the whole actinal floor in *Hymenaster*, are designated the *actino-lateral spines*. Finally, in the armature of the mouth-plates distinction is made between (1) the *mouth-spines proper*, which are situated upon the horizontal margins of the plates, and which are usually directed over the actinostome; and (2) the *secondary* or *superficial mouth-spines*, which are borne upon the surface of the plate, and usually stand perpendicular to its plane—these latter spinelets being also frequently larger and more robust than the mouth-spines proper.

PTERASTER, *Müller & Troschel.*

Species enumerated.

P. militaris (O. F. Müll.), Müll. & Trosch.	*P. rugatus*, n. sp.
P. affinis, E. A. Smith.	*P. stellifer*, n. sp.
	P. semireticulatus, n. sp.

PTERASTER MILITARIS (*O. F. Müll.*), *Müll. & Trosch.*

Station 49. Lat. 43° 3′ N., long. 63° 39′ W. Depth 83 fms.; bottom temperature 1°·8 C.; gravel, stones.

PTERASTER AFFINIS, *E. A. Smith.*

Pteraster affinis, *E. A. Smith, Ann. & Mag. Nat. Hist.* (1876), vol. xvii. p. 108; *Trans. Venus Exped., Zool. Kerguelen Is.* p. 6, pl. xvi. fig. 5.

Station 149. Royal Sound, Kerguelen Islands. Depth 25 fms.

PTERASTER RUGATUS, n. sp.

Marginal contour subpentagonal, interradial angles scarcely indented, the lesser radius being in the proportion of 68·4 per cent.; $R=9{\cdot}5$ millim., $r=6{\cdot}5$ millim. Interradial margin rounded, extremities of the radii slightly upturned, exposing the end of the furrow. Dorsal profile rounded, not high, tapering but little towards the extremities of the radii. Abactinal surface flat or slightly convex. Lateral fringe very slightly produced beyond the margin of the test.

Supradorsal membrane subcorrugated, not reticulated. Paxillæ-spinelets fine, about 5 or 6 in number; tips slightly protuberant, and producing a slight papillate appearance on the dorsal surface; no regularity of arrangement perceptible. Membrane indurated with minute spicules averaging ·03–·04 millim. in length—small, irregular and angularly branching bodies, sub-

dendriform in appearance, fairly well spaced. The spiracula are rather large, not numerous, and are irregularly placed.

Ambulacral furrows narrow, uniform in breadth till near the extremity, not petaloid. Ambulacral suckers in regular simple pairs. Ambulacral spinelets short and rather robust, 3 to 4 in each comb, 3 only on the outer part of the ray. Innermost spine nearly as long as the others, or, if a small inner one is present, it is so aborted as to be invisible without dissection. Web remarkably thick and fleshy, subsaccular over the spinelets, passing off from the outermost spine with a long gentle sweep far out on to the lateral fringe.

Mouth-plates each bear on their margin about three rather short, robust mouth-spines webbed together. Secondary superficial mouth-spines one on each plate, perpendicular to the plane, longer than any of the other spines, exceedingly thick, triangular, translucent, sharply pointed, and covered with a thick fleshy investment.

Aperture-papillæ large, prominent, subtriangular. Actinolateral spines directed horizontally, comparatively long, especially in the interbrachial space. Web rather thick and fibrous.

Colour, in alcohol, greyish white.

Station 150. Lat. 52° 4′ S., long. 71° 22′ E. Depth 150 fms.; bottom temperature 1°·8 C.; rock.

PTERASTER STELLIFER, n. sp.

Marginal contour stellato-pentagonoid, interradial angles slightly indented, the minor radial proportion being 67·6 per cent.; $R=34$ millim., $r=23$ millim.

Radii very broad at the base, and tapering to a fine extremity, which is slightly recurved, margins of the rays not curved outward. Dorsal surface depressed and flatly convex. Lateral fringe scarcely extending beyond the margin. Actinal surface flat.

Supradorsal membrane rather thick, regularly papillose in appearance, not reticulated, composed of closely interlacing fibrous tissue. Paxillæ numerous and closely placed, with crowns of usually six spinelets radiating round a central one; expansion of spinelets slight, all uniformly protuberant. The tips of the spinelets elevate the membrane into little conical papillæ, which, in consequence of the regularity of the crowns of the paxillæ, have the appearance of forming six-rayed stars with a central papilla, raised slightly in relief above the general superficies.

The crowns are closely placed, the interspaces rather deep; and the stars often appear to overlap. A more or less distinct lineal arrangement of this ornamentation may be observed upon the rays, although here and there irregular paxillæ-crowns, with fewer or more minute spinelets as the case may be, are interspersed. The "stars" diminish in size as they proceed outward on the ray. Spiracula small and rather widely spaced. Oscular orifice small; spinelets of the valves short and crowded.

Ambulacral furrows narrow, straight, not petaloid, converging gradually towards the extremity. Suckers arranged in simple pairs. The borders formed by the transverse combs of ambulacral spinelets rather broad. Each comb with 5 spinelets, comparatively short, the innermost one diminutive, not half the length of the others, and placed aboral to them on the plate, the comb being thus curved round aborally at the margin of the furrow; the spine next to the outermost is usually the longest. Web moderately thick and semitransparent, rather deeply incurved between the spinelets, somewhat thickened round them, and slightly sacculate over their extremities; continued from the outermost spine of the comb far out on the actino-lateral spines.

Segmental apertures rather large and conspicuous for this genus. The papilla is comparatively large, and free on its aboral side only, forming a regular semicircular lip, the remainder of the papilla being entirely hidden in membrane.

Mouth-plates short, but widely expanded laterally, rising by a gradual slope into a high and angular median keel, and forming a prominent peak aborally. Each plate bears one moderately robust secondary superficial spine placed rather nearer the anterior margin of the plate than the middle. These spines are shorter than the mouth-spines proper, and are covered with a thick investing-membrane slightly sacculate at the extremity. Five mouth-spines are situated on the horizontal margin of each plate, the innermost the longest, the next slightly smaller, and the outer three much smaller. Each of the spines is covered with a moderately thick subsacculate investing membrane; and no web is developed, except in one single abnormal instance, where a secondary spine is united with the inner or first mouth-spine proper.

The first or most adoral transverse ambulacral combs of two neighbouring rays touch one another at their bases behind the aboral peak of the mouth-plates, but are not joined together.

The actino-lateral spines are long, delicate, closely placed, and

extend to the margin of the actinal surface; the web faintly rounded over their extremities and slightly festooned between. The spines are horizontal in their disposition, forming a flat ventral surface to the disk; and the fringe extends very slightly beyond the margin; and the spines diminish to quite microscopic proportions at the extremities of the ray.

Colour, in alcohol:—The actino-lateral spines, the ambulacral spines, the mouth-plates, and the mouth-spines are all of a delicate rosy-pink colour; and this, seen through the semitransparent light-flesh-coloured investing tissue, gives an exquisitely beautiful appearance to the underside of the Starfish. The general colour of the dorsal area is a pinkish white, verging on flesh-colour.

Station 311. Lat. 52° 50′ S., long. 73° 53′ W. Depth 245 fms.; bottom temperature 7°·7 C.; mud.

PTERASTER SEMIRETICULATUS, n. sp.

Marginal contour substellate; interradial angles well indented, the minor radial proportion being 57 per cent.; $R=14$ millim., $r=8$ millim. The sides of the rays slightly and gracefully curved outwards, the tips naturally upturned and incised, bringing the extremity of the ambulacral furrow on to the dorsal area. Dorsal profile rather high and bombous over the disk, tapering off rather steeply to the extremity of the rays. Actinal surface slightly concave.

Supradorsal membrane marked out with conspicuous reticulated lines of membrane, although no regular divisional fibres or independent tendinous network can be made out—the fibres present being fine, and only distinguishable when highly magnified. Paxillæ moderately long, with the spinelets radiating well outwards, about 6 to 8 or even more in number; the corrugated membrane which they support lying thick and baggy over their tips, and forming the regular lines and cross lines whereby the character above noted is produced. None of the spinelets are more prominent than the rest; and although a central one appears to be normally present in the centre of the mesh, this is very frequently absent towards the end of the rays. The membrane is semitransparent, and contains no spicules; 6 to 10 large-sized, irregularly disposed spiracula occur in each mesh-like area

Ambulacral furrows moderately wide and sublanceolate; the sucker-feet more or less alternate, and showing distinctly a ten-

dency towards quadruple arrangement. Ambulacral suckers moderately long and slender, each comb having 3 to 4 (or occasionally 5) spinelets, the innermost not more than one third of the size of the next spinelet, and placed in advance of, or aboral to, the rest of the comb; the outer spinelet usually rather longer than the others. The web-membrane is semitransparent, moderately indented, and, after passing from the outermost spinelet of the comb, is attached to the web of the actino-lateral spine, slightly in advance of the actino-lateral spine belonging to its own adambulacral plate—the spinelet hanging right over the terminal piece of web, which does not reach far out as in *P. rugatus*. A rather long saccular prolongation of the web-membrane occurs at the tip of each of the ambulacral spines. Towards the extremity of the rays the combs sometimes show a tendency to separate into component spines, each being still clothed with membrane. The aperture-papillæ are somewhat jawbone-shaped, the thickened extremity being directed adorally.

The mouth-plates bear 4 to 5 spines on each side, long, and stouter than the ambulacral spines, both series being webbed together, the outer spine being sometimes very small and rudimentary. The secondary superficial spines are small, not so long as the innermost mouth-spines, but rather more robust. In one or two plates of the specimen under notice there is a single irregular secondary spinelet, smaller than and accompanying those just referred to. The first ambulacral comb after the mouth-plate series has its web continued on to the aboral extremity of the mouth-plate; hence these two combs meet.

The actino-lateral spines are of moderate length and slender; the fringe extending a short distance free beyond the margin of the test, and directed horizontally or in the plane of the ventral surface.

Colour, in alcohol, greyish white.

Station, "off Marion Island." Depth 50 fms.

Retaster, *Perrier*.

Species enumerated.

R. verrucosus, n. sp.	*R. gibber*, n. sp.
R. peregrinator, n. sp.	*R. insignis*, n. sp.

Retaster verrucosus, n. sp.

Marginal contour moderately indented in the interradia, which

are angular and not rounded; outline of the rays gracefully curved outwards. The lesser radius in the proportion of 59·5 per cent.; $R=47$ millim., $r=28$ millim. Dorsal profile moderately high and rounded, tapering gradually to the extremity of the rays, which are slightly upturned and expose the ambulacral furrow on the dorsal area. Actinal surface flat.

Supradorsal membrane very regularly and uniformly reticulated. The paxillæ have long pedicels, and bear a crown of about 15 spinelets, nearly as long as the pedicel. The central spinelet is very much more robust and longer than any of the rest, and stands perpendicular, rising in the centre of the mesh, whilst the others, which are slender and delicate, radiate round it and outwards to the fibrous bands that form the outline of the mesh. The median spinelet is much more prominent than any of the others; and the thick fleshy cap formed upon it by the dorsal membrane imparts a very conspicuous papillate appearance to the Starfish, assuming in large old specimens almost a semituberculate character of great regularity and evenness of disposition. In large, fully-grown specimens the whole membrane becomes very thick and wrinkly, rendering it difficult to trace the radiating bands; in moderate-sized specimens, however, they may be clearly distinguished without removing the epidermis. From the central spinelet 6 to 8 secondary muscular fibres radiate up to the main fibres of the mesh; they are of considerable thickness, and leave only narrow interspaces, in which four or five small spiracula occur.

Ambulacral furrows very broad and petaloid in outline, with sucker-feet arranged in quadruple series. Transverse combs of ambulacral spines numerous and closely placed, with five moderately long and robust spines, the uniting web being thick, fleshy, and with long saccular prolongations extending beyond the tips of the spines. The ambulacral spinelets are nearly equal in length, except the innermost, which is shorter and more delicate. Each alternate row is somewhat retired from the furrow-margin; and in these combs the innermost spinelet is very much smaller than its companions, in some cases almost aborted; and this spine is usually placed rather in advance of its row.

Mouth-plates with long mouth-spines, 4 on each plate, all the eight webbed together, not radiating apart, but forming a narrow scoop-like fan, the inner three spines on each plate about equal in length, the outermost spine very small and short. The secon-

dary or superficial mouth-spines (one on each plate) not longer than the mouth-spines, scarcely if at all stouter, subcylindrical and not pointed, covered rather thickly with membrane.

Actino-lateral spines completely hidden in a very thick fleshy membrane, which extends as a saccular prolongation beyond their extremities, forming an aborted lateral fringe that projects slightly beyond the margin of the disk and rays.

Colour, in alcohol, varying from light warm brown to purplish grey.

Station 313. Lat. 52° 20′ S., long. 68° 0′ W. Depth 55 fms.; bottom temperature 8°·8 C.; sand.

RETASTER PEREGRINATOR, n. sp.

Marginal contour not greatly indented, the lesser radius being in the proportion of 65·85 per cent.; $R = 41$ millim., $r = 27$ millim. Interradial angles subangular or faintly rounded. Radii short, thick, blunt and rounded at the extremities, which are slightly upturned. Dorsal profile bombous and rather high. Actinal area flat or subconvex.

Supradorsal membrane thick and regularly reticulated. Paxillæ with a crown of 5 to 10 spinelets, one directed to the centre of the mesh, the rest expanded very slightly; six radiating fibrous bands pass from the central spinelet to the mesh-fibres; and the interspaces include 2 or 3 large spiracula. All the spinelets are uniformly protuberant, and that only to a slight degree; they are rather closely placed; and the whole dorsal area is thickly covered with rather fleshy wrinkly skin, presenting a somewhat spongy and subpapillose appearance, and a slightly scabrous feeling to the touch. The primary meshes are not very distinctly marked out superficially; and the hexagons consequently appear to overlap or run into one another in many cases. Oscular orifice small and inconspicuous.

Ambulacral furrows broad and more or less petaloid, the closely placed and prominent transverse spine-combs adding greatly to the appearance of breadth. Sucker-feet arranged in quadruple series. The combs of ambulacral spines are broad, a feature further enhanced by their method of arrangement. Each alternate comb has usually two spines less: in this way combs of 7 to 8 spinelets alternate regularly with combs of 5. The larger combs radiate well over the furrow, whilst the smaller ones, on the other hand, are considerably retired from the margin; the

innermost spine standing perpendicular, or even directed slightly outwards. Hence, when seen from above, the smaller combs appear to have little more than one half, or at most two thirds, the space of the larger combs. In the larger combs the innermost spine is smaller and shorter than the rest, frequently not more than half the length. In the smaller combs the innermost spine is much smaller still, often quite aborted and apparently absent. The other spines are nearly equal in length; and both combs are uniform with one another in this respect. The combs are thickly webbed, and have large and elongate saccular extensions developed over the extremities of the spinelets.

Mouth-armature resembling that of *R. verrucosus*. Mouth-spines 8 to 10 in number, 4 or 5 on each plate, both series webbed together, forming a narrow scoop-like fan. Secondary superficial mouth-spines, one on each plate, thin, cylindrical, not tapering, no longer than the mouth-spines, covered with membrane.

Actino-lateral spines of moderate length, reaching up to the margin of the test; hidden in membrane, of which a saccular but not indented prolongation extends beyond the extremities as a fleshy marginal fringe. Segmental apertures of the dorsal chamber very large and elongate, situated well within the transverse combs, and quite hidden thereby.

Colour, in alcohol, purplish grey.

Station 149. Off Christmas Harbour, Kerguelen Islands. Depth 120 fms.

Retaster gibber, n. sp.

Marginal contour substellate, interradial angles acute, not rounded. Minor radial proportion about 50 per cent.; $R=28$ millim., $r=14$ millim. Radii 5, well rounded, tapering continuously from the angle to the extremity, with sides rounded, tumid, and curving over on to the actinal area as in *Echinaster*. Dorsal profile high, gibbous, rounded. On the actinal area the mouth and surrounding portions are deeply sunken.

Supradorsal membrane with reticulated fibrous bands, marking it off into square or rhomboid meshes of great regularity. In the centre of each, 3 to 4 paxillæ-spinelet-tips are visible; and other spinelets radiate to the mesh-fibres, one (or occasionally two) spiracula being situated in the interspaces. The white fibres of the meshes form a conspicuous feature; and the slightly

protrusive tips of the spinelets impart a granulose appearance to the dorsal area, the whole being covered with a thin fleshy membrane. The oscular orifice is small, closed by a number of subpapillate spinelets, rather longer, more prominent, and more robust than those of the paxillæ proper.

Ambulacral furrows narrow and deeply sunken. Ambulacral combs quite within the furrow and below the level of the test, with 3 to 5 spinelets, which are short, rather robust, webbed together,—the membrane being very slightly indented and with a slight knob over the end of each spinelet. Ambulacral suckers completely hidden by the overarching combs.

Mouth-plates deeply sunken; mouth-spines longer than the ambulacral spines, 3 on each plate, the whole six being webbed together into a continuous comb. Each plate bears one large isolated secondary or superficial spine, longer than the mouth-spines, very robust, covered with a thick membrane, except at the tip, which is translucent and sharply pointed.

Segmental apertures elongate and narrow; papillæ free on the aboral side only.

Actino-lateral spines very short and robust, almost hidden within the furrow, of which they appear to form the sides, and only protrude a short way beyond the level of the test, standing nearly perpendicular to the plane of the ray, and in some parts showing a tendency even to arch over the furrow slightly. This disposition, together with the aborted character of the fringe, imparts a feature very different from that usually presented by this structure in *Pterasteridæ*. In the immediate angle, near the peristome, the actino-lateral spines are somewhat longer, and are laid over upon the rounded surface of the interbrachial area, their web being continuous and forming a smooth fleshy triangular area leading up to the mouth-angle.

Colour, in alcohol, yellowish or greyish white.

Station 311. Lat. 52° 50′ S., long. 73° 53′ W. Depth 245 fms.; bottom temperature 7°·7 C.; mud.

RETASTER INSIGNIS, n. sp.

Marginal contour stellate, five-rayed. Interradial angles well rounded. Minor radial proportion 44·4 per cent.; $R=45$ millim., $r=20$ millim. (in another example $R:r$ as $70:31$). Rays very slightly tapering, obtusely rounded at the extremities. Dorsal surface moderately convex, rays uniformly rounded from the

margin. Under surface flat or subconcave, somewhat impressed round the actinostome.

Supradorsal membrane very conspicuously reticulated. Paxillæ-spinelets prominent, arranged in regular lines, joined by fibres forming large uniform rhomboid meshes, which are rendered still more distinct by the lines and the investment of the spinelets being of a dark purple or black colour, whilst the dorsal membrane generally is ashy white. The meshes are filled in with a closely and regularly reticulated tissue, the interspaces of which are small, equally spaced, and each punctured with a minute spiraculum. The opposite angles of the rhomboid areas are usually joined by fibres rather more robust than the rest, forming a right-angled cross in the centre, and marking off the reticulated area of the mesh into four more or less easily distinguishable sections. There are 80 to 100 or more spiracula in each mesh. The spinelets that stand at the angles of the meshes protrude more than the others, and appear like well-developed thornlets springing from the general surface. Oscular orifice small and constricted, the spinelets of the pseudo-valves slightly prominent, their extremities tipped with the same dark colour as the lines of reticulation above mentioned.

Ambulacral furrows narrow, straight, and sunken—their apparent depth being further increased by the position of the prominent fringe of the actino-lateral spines, which stands vertical on either side of the furrow. Ambulacral spines 5, united together by a web; three standing on the margin of the plate parallel with the furrow, the next (more adoral) placed more outwards and away from the furrow, and the fifth more outwards still. The innermost (*i. e.* aboral) spine is very small, each succeeding one in the comb increasing in length; all are comparatively short, delicate, and tapering. The membrane that unites the spinelets is very fine, semitransparent, and deeply festooned between the spinelets, and is continued from the outermost spine of the comb on to the adjacent actino-lateral spine. The small spines placed on the margin detract very slightly from the general transverse aspect of the combs, their smallness rendering them inconspicuous; they have, however, the peculiarity of closing the space between their own and the next aboral comb at the margin of the furrow. Aperture-papillæ small and sublanceolate in form, hidden in the general membrane, excepting their

aboral side, which alone is free, which closes the aperture, shutting close up to the next aboral actino-lateral spine.

The mouth and parts surrounding it are much sunken—a feature further emphasized by the deep wall of the continuous marginal fringe. Mouth-plates elongate, with their aboral extremities produced into a rather prominent peak, suggestive of that in *Hymenaster*. About five mouth-spines are borne on the outer margin of each plate, the innermost much longer and more robust than the others, all webbed together, forming an elegant marginal comb conformable to the contour of the plate. The innermost spines of the two adjoining plates stand close together, but are not united by web. On the superficies of each plate, and nearer the mouth than midway, is a long, robust, cylindrical, rapidly tapering, pointed secondary spine, standing isolate and perpendicular, covered with membrane, but with no web-attachments.

Actino-lateral spines short and robust, not more than one third longer than the outermost ambulacral spine, and tapering only very slightly. They are united by a close fibrous web, the margin of which and the tips of the spines (as well as the tips of the ambulacral spinelets in the transverse combs) are tipped with dark purple. The lateral fringe thus formed stands perpendicular on the margin of the furrow; and the spines comprising it would at first sight be thought to belong to the comb-series. The fringe of the adjacent sides of two neighbouring rays is merged together at their adoral extremity, forming a continuous fringe, which runs close past the aboral end of the mouth-plates.

Station 189. Lat. 9° 36′ S., long. 137° 50′ E. Depth 25–29 fms.; mud. Also off Booby Island.

MARSIPASTER, n. gen.

Form depressed, marginal contour pentagonoid, dorsal area flatly convex, actinal area plane. Supradorsal membrane an irregularly developed, somewhat spongiform tissue. No muscular fibrous bands. No spicules. Paxillæ with moderately expanded crowns composed of a great number of fine, long, hair-like spinelets (15–30), their extremities protruding freely through the membrane. Paxillæ invested with a well-developed membranous envelope. Ambulacral spines webbed together, forming transverse combs; spinelets more or less horizontal in position, overspanning the furrow. Mouth-plates with one secondary surface-spine, connected

with the mouth-spine series by a continuation of the web. Mouth-spines three on each plate, webbed together. Actino-lateral spines merged in the actinal floor; no independent marginal fringe.

This genus is nearly related to *Pteraster*,—from which, however, it is distinguished by the rudimentary character of the supradorsal membrane, devoid of muscular fibrous bands; by the actino-lateral spines being merged in the actinal floor; and by the absence of a marginal fringe. Furthermore, the numerous hair-like spinelets of the paxillæ protruding through the membrane give a peculiar character to the dorsal area; and the ambulacral spines, from their high position in the furrow and from their more or less horizontal direction, present a feature unknown in the other members of the group.

MARSIPASTER SPINOSISSIMUS, n. sp.

Marginal contour pentagonoid; radii somewhat produced; interradial angles widely rounded, forming a continuous curve from tip to tip. Lesser radius in the proportion of 62·5 per cent.; $R=16$ millim., $r=10$ millim. General form depressed; dorsal area slightly convex, tapering off gently to the extremity of the rays.

Supradorsal membrane very fine and thin, somewhat irregular, and forming a continuous spongiose mass, rather than a definite membranous sheet, through which the spinelets of the paxillæ protrude freely. No specialized muscular fibrous bands present. Spiracula very few, widely and irregularly spaced.

The paxillæ have long pedicels and a crown consisting of a great number (20–30 at least upon the disk) of very fine hair-like spinelets, which radiate at a small angle from the perpendicular, crown and pedicel alike being invested with a delicate membranous tissue, the whole appendage seen in profile bearing a fanciful resemblance to an umbrella when turned inside out. The investing membrane merges into the general spongy tissue above mentioned; and a considerable length of the extremities of the spinelets protrudes free and naked. The paxillæ are numerous; and their crowns join up close together. Owing to these circumstances and to the great number of the spinelets, the dorsal surface presents the appearance of a coarse, irregular velvet pile. Oscular orifice small and quite inconspicuous; valves consisting of a flattened crown of rather more robust spinelets.

Ambulacral furrows rather broad, not petaloid, tapering towards the extremity. Sucker-feet arranged in simple pairs. Ambulacral spinelets 5, long, acicular, webbed together into transverse or obliquely curved combs, and remarkable for their position more than half within the furrow. Spines of unequal length, the innermost much smaller than any of the others, and placed somewhat in advance of, or aboral to, the series; the longest spine usually the middle one, or sometimes the second from the outside, in length nearly equal to the breadth of the furrow, across which it stretches horizontally, whilst the two outer spines radiate downward and aborally. Consequent on this position of the median spine, the spinelets which compose the outer half of the comb radiate very widely apart. The connecting web is fine and semitransparent, very deeply indented between the spinelets, the combs receiving thereby a remarkable appearance; and the web is continued from the outer spine of the comb down to the base of the aperture-papilla, and not out along the actino-lateral spine. The aperture-papilla is represented by a small conical spinelet placed on the outer edge of the adambulacral plate and between the bases of the actino-lateral spines; it is covered with membrane, that of the ventral area being stretched over it, giving it the form of a small subtriangular or conical peak.

Mouth-plates of moderate length, with widely expanded lateral flanges. Keel along the line of junction prominent, forming a well-developed peak aborally, hidden beneath the tissue of the ventral membrane, produced into a point adorally. On either side of this, and placed on the horizontal margin of the plates, are three mouth-spines, webbed together, about equal in size with the ambulacral spines, but rather more robust, the innermost spine on each plate longest, and the other two decreasing in series. Immediately behind the three mouth-spines stands a small secondary superfical mouth-spine, about the same size as, or smaller than, the innermost mouth-spine, with which it is connected by a continuation of the web; the pseudo-comb being thus bent upon itself at a sharp angle, gives a very striking character to the armature of the mouth-plates. The ambulacral spines that form the comb belonging to the first adambulacral plate have their bases arranged in a semicircular curve, and the spines radiate at equal distances apart and are directed downwards and adorally, the middle spine being longest. The spines are all webbed together: and a continuation of the tissue from

the outermost spine is attached to the prominent posterior or aboral portion of the median keel of the mouth-plates, and there coalesces with the web of the corresponding comb of the neighbouring ray, thus forming an elegant compound pair of fans that arch over the aboral peak of the plate.

Actino-lateral spines rather short and robust, not extending, or only to the very slightest degree, beyond the margin. They are united by a fine semitransparent membrane, slightly indented between the tips, which also forms the actinal floor of the test. Probably in this species there is no free extension of the lateral or marginal fringe, such as occurs in more shallow-water forms, but unfortunately the preservation of the specimens in this portion of their structure is imperfect. For the same reason it is difficult to determine with accuracy the number of actino-lateral spines, but probably about 20 to 22 were present: 17+ may be counted in natural position; the sixth from the mouth appears to have been the longest.

Colour, in alcohol, brownish grey.

Station 286. Lat. 33° 29′ S., long. 133° 22′ W. Depth 2335 fms.; bottom temperature 0°·8 C.; red clay.

MARSIPASTER HIRSUTUS, n. sp.

Marginal contour substellate, interradial angles well indented, the lesser radius being in the proportion of 60·2 per cent.; $R=13·5$ millim., $r=8·5$ millim. Radii broad at the base, bounded by lines running direct from the arm-angle, with little if any curve or rounding. Dorsal area moderately convex, radii slightly upturned at the extremities.

Supradorsal membrane a fine, irregular, and somewhat spongiose tissue continuous over the whole area, through which the extremities of the spinelets of the paxillæ protrude freely. No definite membrane; no muscular fibrous bands. Paxillæ with long robust pedicels bearing 10 to 15 fine, long, acicular spinelets; investing membrane of the crown merging into the general supra-dorsal tissue; the naked tips of the spinelets which pass through the tissue giving the surface a somewhat hirsute or prickly appearance. Spiracula comparatively large, very few in number, and very widely spaced. Oscular aperture inconspicuous; valves formed of spines similar to the rest of the paxillæ, and with no specialized external characteristics.

Ambulacral furrows broad and straight, not petaloid. Sucker-

feet arranged in simple pairs. Ambulacral spinelets 5, forming transverse combs. The two innermost spines much smaller than the rest, and standing parallel with the furrow, rather in advance of, or aboral to, the other three, which are disposed across the broad adambulacral plate, articulated on more or less definite tubercles, and forming a series at right angles to the furrow. The middle spine is longest. The whole series webbed together with membrane deeply indented between the radiating spinelets, but not nearly so much as in *Marsipaster spinosissimus*.

Mouth-plates broad, having wide lateral expansions, and with an elevated ridge along their line of junction, developing a prominent peak aborally and a rounded point inward. The armature consists of three long, robust mouth-spines placed on the horizontal margin of each plate, the innermost spine largest and longer than the ambulacral spinelets, the outermost less than half its size, and sometimes accompanied by an additional diminutive spinelet. The inner spines stand well away from the adoral point of the united mouth-plates, which becomes in consequence rather conspicuous. Immediately behind or aboral to the mouth-spines proper is a single superficial or secondary mouth-spine, smaller than the long mouth-spines. The three mouth-spines of each plate are webbed together by a semitransparent membrane deeply indented between; and the secondary spine is united to the innermost spine by a continuation of the web. The long, innermost spines are directed towards the centre of the mouth, where they almost meet, the other spines radiating slightly outward from this. The first, or most adoral, comb-series forms a widely expanded semicircular fan, the web being continued and attached to the prominent aboral peak of the mouth-plates.

Actino-lateral spines robust, but short; character of the fringe destroyed, probably more or less distinct along the rays; spines not reaching to the margin in the interbrachial angle, but merged in the membrane of the ventral floor. The margins of the rays and disk are well rounded and regularly covered with the intrapaxillar tissue continuous from the disk; indeed the greater part of the ventral portion of the interradial space is thus provided.

Colour, in alcohol, brownish grey.

Station 299. Lat. 33° 31′ S., long. 74° 43′ W. Depth 2160 fms.; bottom temperature 1°·1 C.; grey mud.

CALYPTRASTER, n. gen.

Form depressed, marginal contour pentagonal, dorsal area plane, actinal area convex. Supradorsal membrane very delicate, perfectly transparent. No muscular fibrous bands. Spiracula present. No spicules. Paxillæ with short robust spinelets (5 or 6 in the type species), usually flaring at the extremity, crown widely expanded, not protruding through, or even elevating, the membrane, simply supporting it. Ambulacral spines forming transverse combs; spinelets perpendicular in position, webbed together. Segmental apertures present. Aperture-papillæ not free, opening laterally only. Mouth-plates with two or three pairs of superficial secondary spines. Mouth-spines proper 2, or occasionally 3. Actino-lateral spines merged in the actinal floor. No independent lateral fringe.

This genus is established for the reception of a very elegant little form which presents certain resemblances to *Hymenaster* and certain to *Pteraster*. It resembles *Hymenaster* in the absence of a marginal fringe, and in the merging of the actino-lateral spines in the actinal floor, and resembles *Pteraster* in its transverse combs of ambulacral spines united by web-tissue. It differs from both genera in its transparent supradorsal membrane devoid of muscular fibrous bands, by the possession of three pairs of free secondary superficial mouth-spines, and by its true pentagonal form.

CALYPTRASTER COA, n. sp.

Marginal contour pentagonal, interradial angles very slightly incurved. Minor radial proportion 68 per cent.; $R=11$ millim., $r=7{\cdot}5$ millim. Dorsal surface flat, or even somewhat concave in consequence of the rays being slightly curved upward; radial areas not specialized externally, the dorsal membrane forming a plane area. No marginal fringe. Actinal surface convex.

Supradorsal membrane extremely thin and perfectly hyaline, a clean specimen appearing to the eye as transparent as glass. No muscular bands present, although a fibrillar structure may be seen in the tissue under high magnification. Spiracula rather large, numerous, and uniformly distributed. Paxillæ with long pedicels, moderately delicate, evenly and equidistantly placed, usually with five spinelets, which are short in comparison with the pedicel, and rather delicate. A few of the spinelets taper a little at their extremity; but usually they are slightly flaring. The supradorsal membrane is literally supported upon the tips of these spinelets. About nine longitudinal rows of paxillæ-crowns are discernible at the base of a ray. The oscular

orifice is small but very conspicuous, in consequence of the well-developed bosses upon which the valves are articulated, and which are visible through the transparent membrane. The valves are very regular, and composed of 13 or 14 spines—the outer one or two on either side being almost aborted and hidden in the general membrane by which the whole series is webbed together, whilst the two innermost spines are longer than the others, which decrease gradually on either side and form a regular triangular fan, the base of which is articulated on the elongate boss or modified pedicel above mentioned. The bosses stand transverse and regularly central in the median line of each ray; in consequence of their breadth the distance between two neighbouring bosses is very small, and is bridged over by two or three spinelets, whilst a few short spinelets spring from the surface of the boss, and in this manner mark out a pentagonal outline round the orifice. The valves when closed lie flat over the opening, and do not form a pyramid.

Ambulacral furrows wide, lanceolate, scarcely petaloid. Ambulacral spines 4 (in a small specimen 3), of moderate length, rather robust at the base and sharply tapering, arranged at an angle of such great obliquity that, roughly speaking, the series may be described as transverse, although the innermost spine, which is somewhat smaller than the others, is usually more aboral than the rest of its series. The spines are not individually invested with membrane, but are webbed together into combs on at least the inner half of the ray. The web-tissue is extremely thin and very deeply indented between the spinelets; indeed it is only possible to make it out by means of favourable illumination. This character seems to be less general in some specimens than in others.

The aperture-papillæ are small, short, and elongately oval, more or less squamous, but often developing a small thornlet from the surface. They are more or less hidden in membrane, and free only on the aboral side.

Mouth-plates small, but rather elongate and prominent, as if compressed together laterally. Aboral extremity prominent. Adoral peak almost obliterated by the expansion of the lateral flanges. Each plate bears 3 superficial secondary spines (in a small specimen 2), not longer than the ambulacral spines, but nearly twice as robust, thick at the base, and tapering to a fine extremity. They are somewhat bowed or geniculate at right

angles to the line of junction of the mouth-plates. The anterior pair are situated at a little distance from the adoral extremity of the plates; and the second pair, which are slightly larger and rather wider apart, stand midway between them and the aboral extremity of the mouth-plates. Immediately above the anterior pair and placed on the innermost part of the lateral flanges, are a pair of mouth-spines (*i. e.* one on each plate), similar in every respect to the secondary spines just described, only slightly smaller and rather wider apart; indeed, in some specimens one is almost inclined to class them along with the secondary series. Midway on the horizontal margin of the flange is one small pointed mouth-spine; and in a large specimen a second and rather larger spinelet occurs between this and the innermost mouth-spine, and nearer to the latter.

Actino-lateral spines rather robust, well-spaced, tapering slightly at the tips, excepting those spines included within the inter-brachial angle, which are slightly thickened and do not meet their corresponding spines from the neighbouring ray in the median interradial line. There are 25 to 27 actino-lateral spines on each side of a furrow, the 7th or 8th from the mouth being longest; after this they gradually diminish in size as they proceed outward, maintaining, however, a fair length even at the extremity, where they are little shorter than the first (or adoral) spine of the series, thus forming a conspicuous little fringe round the extremity of the ray. The ambulacral furrow is extended vertically up the extreme tip of the ray, but is not exposed on the dorsal surface, being arched over by the terminal spinelets just described. Immediately inside this ocular fringe on the dorsal surface is a little ridge of 8 to 10 minute conical spinelets or papillæ, forming a semicircular collaret at the extreme tip.

The actinal membrane is as transparent as the dorsal membrane, the actino-lateral spinelets forming the floor of the test and projecting only their pointed tips beyond the sharp margin, to which they impart a delicate serrate character.

Colour, in alcohol, a light straw-colour, verging towards golden brown.

Station 122. Lat. 9° 5′ S. to 9° 10′ S.; long. 34° 49′ W. to 34° 53′ W. Depth 350, 120, 32, and 400 fms.; mud. (Unfortunately only the station number is indicated on the label accompanying these specimens; and no record is given as to the particular dredging in which they were obtained.)

Hymenaster, *Wyville Thomson.*

Synopsis of Species herein described.

A. One ambulacral spinelet.
 † Paxillæ-crowns forming raised areas of membrane... } *nobilis.*
  Spiracula small, numerous, equidistantly spaced ... }
 †† Paxillæ-crowns not forming raised areas.
  1. Spiracula single, large, uniformly spaced .... *formosus.*
  2. Spiracula in groups of 6–10, small, irregularly distributed .... *pergamen-* [*taceus.*

B. Two ambulacral spinelets.
 † Muscular fibrous bands of dorsal membrane coherently reticulated.
  * Paxillæ-crowns forming definite areas. } .... *sacculatus.*
   Spinelets not prominent. }
  ** Paxillæ-crowns not forming definite areas.
   Spinelets very prominent.
   1. Spinelets forming a raised keel over each radius. } *echinulatus.*
    Spiracula large, single, distributed. }
   2. Spinelets not forming a raised keel. } *carnosus.*
    Spiracula microscopic, in groups of 10 or more. }
 †† Muscular fibrous bands of dorsal membrane simply intercrossing.
  * Radial areas elevated in relief above the interbrachial tissue. } *glaucus.*
   Paxillæ with three spinelets. }
  ** Radial areas not elevated above the interbrachial tissue.
   Paxillæ with more than three spinelets.
   1. Radii broad. Aperture-papillæ simple........ *vicarius.*
   2. Radii attenuate. Aperture-papillæ comb-like.. *infernalis.*

C. Three ambulacral spinelets.
 † Muscular fibrous bands close, subdiffused, coherently reticulated.
  * Paxillæ-crowns forming definite areas in relief.
   1. Paxillar elevations closely crowded. } *cœlatus.*
    Spiracula uniformly distributed, not in lines. }
   2. Paxillar elevations widely spaced. } *crucifer.*
    Spiracula confined to interspaces, arranged in lines. }
  ** Paxillæ-crowns not forming definite elevated areas.
   a. Ambulacral spines partially webbed. } .. *anomalus.*
    Three pairs of secondary mouth-spines. }
   β. Ambulacral spines not webbed.
    Two pairs of secondary mouth-spines.
    1. Meshes of dorsal membrane irregular and not uniform. } *latebrosus.*
     Ambulacral spines unequal. }
    2. Meshes of dorsal membrane small and uniform. } *porosissimus.*
     Ambulacral spines equal. }
 †† Muscular fibrous bands fine, definite, widely spaced, simply intercrossing.
  * Dorsal membrane with granular bodies .... *graniferus.*
  ** Dorsal membrane devoid of granular bodies.
   α. Ambulacral spines long and needle-shaped.. *geometricus.*

β. Ambulacral spines short and compressed.

1. Muscular fibres very numerous in dorsal membrane. Web of actinal floor with cross muscular fibres. Longest actino-lateral spine 12th. — *pullatus.*
2. Muscular fibres not very numerous in dorsal membrane. No muscular fibres in web of actinal floor. Longest actino-lateral spine 17th. — *membranaceus.*

D. More than three ambulacral spinelets.

1. Ambulacral spinelets 3–4. Aperture-papilla 5–7-rayed, comb-like, large. 1 pair of secondary mouth-spines. .. *coccinatus.*
2. Ambulacral spinelets 3–5. Aperture-papilla simple, small and dumpy. 2 or 3 pairs of secondary mouth-spines. .... *præcoquis.*

HYMENASTER NOBILIS, *Wyville Thomson.*

Hymenaster nobilis, *Wyv. Thoms.* (1876), *Journ. Linn. Soc. Zool.* vol. xiii. p. 73, fig. 11; *Voy. of 'Challenger,' Atlantic,* vol. ii. p. 238, fig. 48.

Marginal contour pentagonal, interradial angles very slightly indented, the margin forming a continuous curve of small degree from tip to tip. Radii not produced, and tapering very slightly beyond the natural angle of a pentagon. The lesser radius is in the proportion of 71 per cent.; $R=138$ millim., $r=98$ millim. General form much depressed, slightly elevated in the centre of the dorsal area. Radial areas very conspicuously defined, the paxillar spinelets being exclusively confined to those areas, which consequently appear to stand at a higher level than the wide interbrachial areas, which are destitute of spinelets and covered with a thick fleshy membrane. Actinal surface flat, the margins of the furrows being rather tumid or convex.

Supradorsal membrane comparatively thin over the radial areas, and rather parchment-like in appearance. The paxillæ usually bear three spines, which are long, prominent, and arranged in triangle. Each spinelet raises the membrane into a sharp conical elevation, each maintaining its individuality, the subtriangular area in the centre of the paxillar crown remaining, however, more or less elevated above the general level. The paxillæ are arranged in regular longitudinal lines along the rays, three on each side of the median line, which is left free. The spinelets that compose the crowns are likewise remarkably uniform in disposition, two standing aboral to the third, which is opposite to their interspace; the base of the triangular crown-area thus formed is consequently at right angles to the median line of the ray, and the apex is

directed adorally. In the outermost row, however, on each side of a ray, this arrangement is more or less modified in consequence of lateral compression of the paxillæ-crowns—these being more compact and with the spinelets less regular in their disposition. The oscular orifice is large and very conspicuous, the valves composed of about a dozen moderately long, rather fine spinelets, all of which are webbed together; the valves expanding fan-like when opened, and forming a prominent vertical wall to the orifice. The spiracula are small, very numerous, closely and equidistantly placed, occupying the whole interspace between adjacent paxillar crowns. Very remarkable elongated tracts or lines of spiracula and an accompanying wrinkled membrane extend from the paxilliferous radial areas out upon the fleshy interbrachial membrane, which has the appearance of being inlaid with them. These lines are slightly curved, nearly equal in length to the half of the radial area, placed regularly parallel with one another and directed at an angle inward in relation to the direction of the ray.

Ambulacral furrows broad, almost straight, very slightly petaloid. Ambulacral suckers large and robust, arranged in simple pairs. Ambulacral spinelets, one to each plate, rather short, invested with a wide membrane which extends beyond the tip as a saccular prolongation twice as long as the spinelet itself. Aperture-papillæ large, fleshy, subspatulate or oval, occupying nearly the whole space between the bases of the actino-lateral spines.

Mouth-plates forming a broad rounded ridge at their line of junction, prominent aborally. Each plate bears one short secondary surface-spine with wide investing sacculus, placed about midway on the plate, quite behind the mouth-spines, the pair being very widely separated. Mouth-spines 3, short, conical, placed on the margin of the lateral flange of the plate, with saccular investments.

Actino-lateral spines about 45+ in number on each side of a furrow, hidden in the thick fleshy tissue, which forms little channels or wrinkles between each, giving a fluted appearance to the interbrachial area on the underside of the Starfish. The longest spines are little more than the extreme breadth of the ambulacral furrow—a wide space, greater at the margin than the length of the spines themselves, intervening in the interbrachial area between their extremities and those of the spines of the neighbouring ray The spines are directed slightly backward (*i. e.* adorally in relation to the direction of the ray); and the series of those spines whose

extremities terminate in the ray-margin diminish very rapidly in length.

Colour in alcohol: Dorsal surface greyish-white, tinged with purple on the radial areas, the interradial areas and fringe being purplish grey. Actinal surface livid purple. Ambulacral suckers yellowish grey.

Station 158. Lat. 50° 1′ S., long. 123° 4′ E. Depth 1800 fms.; bottom temperature 0°·3 C.; *Globigerina*-ooze.

HYMENASTER FORMOSUS, n. sp.

Marginal contour subpentagonal, interbrachial angles very slightly indented, the lesser radius being in the proportion of 73·6 per cent.; $R=19$ millim., $r=14$ millim. General form depressed, dorsal area rising slightly conoid in the centre. Radial areas not specially defined, although to a certain extent indicated, the papillæ-spinelets being confined to the rays and not encroaching on the median interbrachial portion of the membrane. Marginal fringe very narrow, faintly crenulated, tips of spines rounded and thickened.

Supradorsal membrane semitransparent, with closely and regularly reticulated muscular fibrous bands, the bands (which are robust and massively coherent) forming definite meshes over the entire area. The disposition of the tendons is not in any definable relation to the spinelets. Each mesh is filled up with a fine transparent tissue, in the centre of which is a single large spiraculum, surrounded by a conspicuous white ring. Consequent on the number and regularity of the meshes, the whole area is closely and uniformly covered with spiracula.

The paxillæ are few in number and bear 3 to 5 (or more) robust spinelets, which are well expanded and distributed pretty uniformly over the area, excepting the median interbrachial space. The rounded tips of the spinelets do not protrude, but simply elevate the dorsal membrane into little rounded tubercles, which rise directly from the surface like warts, and, owing to their somewhat sparse distribution, impart a very characteristic appearance to the dorsal area of the Starfish. Over the median portion of the radii and towards their extremities the tubercles are very much smaller in size and are more closely placed. A conspicuous subpentagonal ring of tubercles surrounds the centre of the disk at the base of the valves of the oscular orifice, the spinelets of fifteen paxillæ contributing to its formation. The

paxillæ stand at the base of each valve, one forming the actual support of the valve, and the other two being placed external to this, one on either side. Usually two of the spinelets of each of the outer pairs of paxillæ radiate outwards and produce a very striking appearance on the dorsal area, as their whole outline and method of arrangement are perfectly discernible in consequence of the semitransparency of the membrane. The oscular orifice is of moderate size, the valves being subregular and closely reticulated.

The ambulacral furrows are narrow and more or less uniform in breadth, except at the extremity, where they taper rapidly, and near the actinostome, where they are also constricted. There is only one ambulacral spinelet to each plate, which is comparatively long and cylindrical, and invested with membrane which develops a more or less extended sacculus at the extremity. Aperture-papillæ elongate, not tapering, nearly uniform in breadth, rounded at the extremity, almost as long as the ambulacral spinelets, and presenting a robust appearance in consequence of the investing membrane.

The mouth-plates are comparatively small, short, and inconspicuous; and the small secondary surface-spine which stands on the median portion of each plate is moderately long and robust. The rest of the armature is indeterminable without damaging the specimen, in consequence of the extrusion of the stomach and other organs.

Actino-lateral spines regular and delicate, the twelfth from the mouth being longest. The spines preceding this one do not meet in the median interbrachial line, but are separated from those of the neighbouring ray by a uniform narrow space, across which muscular fibres pass from side to side, uniting the tips of the corresponding spines on either side. The tissue of the lateral web is thickened along the margin, especially over the extremity of each spine, to which it gives a rounded capitate appearance, the web having the very faintest trace of incurving between the spinelets. The thickening of the membrane just mentioned is much more pronounced in the arm-angle, where all indentation of the web is obliterated and indications are present of a tendency to excrescent growth. A further faint line of thickening can be made out at the union of the dorsal and ventral tissues, which occurs just within the margin, especially round the shaft of the spines.

Colour, in alcohol, greyish white.

Station 158. Lat. 50° 1′ S., long. 123° 4′ E. Depth 1800 fms.; bottom temperature 0°·3 C.; *Globigerina*-ooze.

HYMENASTER PERGAMENTACEUS, n. sp.

Marginal contour stellato-pentagonal; interradial angles moderately indented, although the actual angle is masked by an abnormal development of the actino-lateral spines, which meet there and form a peak, and an irregular excrescence of the web. The minor radial proportion is about 60·5 per cent.; $R=66$ millim., $r=40$ millim. approx. The radial areas are well defined from the lateral fringe, and taper rapidly at the extreme tip to a fine, slightly produced extremity, which is recurved. The "fringe" is more or less irregular, owing to the thickening at the margin and abnormal growth, and is only slightly indented or festooned between the spinelets, the tips of which are rounded and thickened.

Supradorsal membrane thin, smooth and vellum-like. Paxillæ comparatively few in number, bearing 5 to 8 spinelets, which are robust and widely expanded. Although these are in a certain sense regular in their distribution over the area, no definite pattern of arrangement is produced. The extremities of the spinelets do not protrude through the membrane, but simply elevate it into small eminences; and, owing to the thinness of the supradorsal membrane, the outlines of the spinelets which form each paxilla may be more or less clearly discerned. The radii are well defined; and no paxillæ-spinelets occur in the immediate interbrachial portion of the lateral fringe, nor do any spinelets encroach upon a narrow clear space which runs down the median line of each radius. The fibrous bands are very numerous and closely massed together; indeed so great is their development that nearly all individuality of fascicular character is obliterated and they appear to form a compact muscular tissue. In certain lines, however, along the sides of the rays there seems to be a tendency towards a greater and more definite development of fibres in a lineal direction, parallel with the median line of the ray. The spiracula are very few in number, quite microscopic, and occur in little groups of 6 to 10 which are widely and irregularly distributed. The oscular orifice is large, the valves when closed forming a cone of small elevation; and the spines which compose them are somewhat irregular both in number and gradation in size.

At the base of each valve is a rather close aggregation of paxillæ-spinelets, whereby a more or less complete annulus is formed around the orifice; and from each of the five groups in question proceed a number of spinelets, which radiate outward from the centre and constitute a conspicuous feature.

Ambulacral furrows very wide, subpetaloid, tapering to a fine extremity, and constricted slightly near the actinostome. Ambulacral spines, only one to each plate, long, cylindrical, tapering to a fine point, and placed on a small process projecting into the furrow. Aperture-papilla elongate, covered with very widely expanded membrane, imparting an acumino-spatulate form.

The mouth-plates are long and thin, the pair having the appearance of being pressed together laterally, projecting aborally in a prominent rounded keel, and sloping off somewhat ploughshare-like towards the mouth. Two spinelets, similar to the general ambulacral series, only perhaps rather shorter, stand on the superficies of each plate, one on the sloping curve leading to the adoral margin, and one aboral to this and more outward in relation to the median suture-line of the plates. These spinelets appear greatly modified both in character and position from the usual robust secondary spinelets of the genus. The mouth-spines are represented by two spinelets, similar in all respects to the ambulacral spines, only rather shorter, placed on the horizontal margin of each plate, and close up to the junction with the first adambulacral plate.

Actino-lateral spines very long, the longest being about the 15th from the mouth. In the inner part of the ray they are comparatively delicate, when regard is had to the size of the specimen—increasing, however, in robustness as they proceed along the ray, those near the angle and the succeeding ones being strong and thick. The spines reach quite up to the median line of the interbrachial area; indeed in the outer half they pass beyond and overlap; whilst the longest spines, which fall in the actual arm-angle, are much longer than the distance between the median interbrachial line and the margin of the furrow. In consequence a prominent outward peak is produced in the place of the angle, the web being much contorted, and an abnormal growth not unfrequently taking place, which produces an unsightly excrescence as well as an irregular thickening of the tissue. The outer extremities of the actino-lateral spines are not pointed, but rounded; and the web-tissue is scarcely indented. Owing to the abnormal

growth both of spines and tissue in the interbrachial angle, and the tension produced thereby, the majority of the spines at the extremity of the ray are made to radiate inwards towards the angle, and the web appears considerably stretched.

Colour, in alcohol, yellowish grey.

Station 325. Lat. 36° 44′ S., long. 46° 16′ W. Depth 2650 fms.; bottom temperature $-0°{\cdot}4$ C.; grey mud.

HYMENASTER SACCULATUS, n. sp.

Marginal contour stellato-pentagonoid; interradial indentation small; rays usually recurved dorsally, making the dorsal area deeply concave, the ventral being convex. Minor radial proportion 66·6 per cent.; $R=42$ millim., $r=28$ millim. Radii tapering somewhat sharply at the extremities; marginal fringe distinct and well-developed.

Supradorsal membrane thick and coriaceous in appearance. Papillæ numerous, crowns with rarely more than 4 or 5 spinelets, which are prominently protrusive of the membrane,—that portion lying between the tips of each individual crown being thick, devoid of spiracula, and forming a slightly distended saccular area. Thick bands of tissue, with fibres, radiate between the crowns; and the narrow interspaces are occupied by numerous small spiracula, generally three or four, or even more, in line together, separated only by very fine, thin dissepiments. Oscular orifice large; valves 5 in number, regular, and forming, when closed, a compact exactly fitted pyramid, rising as a small cone in the centre of the concave dorsal area. The spinelets of the valves are of moderate length, thickly webbed, and with numerous spiracula in the interspaces.

Ambulacral furrows moderately wide, very uniform in breadth, except towards the extremity, where they taper rapidly, and near the mouth, where they are also somewhat constricted. Ambulacral spines 2, of moderate length, but with a very long sacculate investing membrane; the pairs standing slightly oblique to the median line of the ray. Aperture-papillæ large, thickly invested, subspatulate, slightly constricted near the outer third.

Mouth-plates elongate, largely keeled, prominent aborally, each plate bearing two short, thick, dumpy secondary surface-spines—one near the adoral extremity, and the other, of similar size and character, standing behind this, about midway on the surface of the plate. Mouth-spines 4, small, short, conical, on the lateral

margin of the plate, ranged serially above and behind the anterior pair of spines just mentioned, and interlocking with the corresponding spines of the neighbouring mouth-angle.

Actino-lateral spines numerous and very closely placed, the longest spine far out upon the ray,—a much greater number being included within the disk-angle than usual. About 40 spines stand on each side of a ray, the 20th or 21st from the mouth being longest. The spines within the disk are comparatively short and uniform in length, and do not quite meet in the median interbrachial line; muscular fibres, however, may frequently be seen underlying the outer tissue, passing from the tips of the lateral spines to the corresponding ones of the neighbouring ray. In the immediate arm-angle, however, the spines are longer than the space between the angle and the furrow; so that a considerable overlap takes place, and a consequent puckering and deformity of the tissue ensues, which appears to develop frequently into an unsightly excrescence. The spinelets succeeding to the long ones taper very rapidly in size towards the extremity of the ray.

Colour, in alcohol, brownish white or grey.

Station 158. Lat. 50° 1′ S., long. 123° 4′ E. Depth 1800 fms.; bottom temperature 0°·3 C.; *Globigerina*-ooze.

HYMENASTER ECHINULATUS, n. sp.

Marginal contour pentagonoid; interradial angles moderately indented, the lesser radius being in the proportion of 72·7 per cent.; $R=22$ millim., $r=16$ millim. The radii are sharply tapered at the extremity, although when seen from above the angles of the pentagon have the appearance of being well-rounded, in consequence of the outspreading and graceful curve of the marginal fringe; this is nipped together laterally at the extreme tip, and a slight upward continuation of the furrow is produced thereby. Form depressed, dorsal area slightly conoid, interradial spaces considerably sunken.

Supradorsal membrane thick and opaque, with very robust broad muscular fibrous bands, closely but irregularly reticulated, the interspaces being small, usually oval, and each occupied by a single spiraculum. Paxillæ rather widely spaced, the tips of the spinelets forming prominent little conical peaks or elevations of the membrane, which on certain parts of the area conform themselves to a regular definite order of arrangement. A curved

row or ridge of these spinelets stands on either side of the median line of a ray, forming a petaloid elevated area, which corresponds with the position of the underlying ray, and imparts a very characteristic facies to the species. A prominent circle surrounds the oscular orifice, marking out in a subpentagonal outline the place of the attachment of the valve-spines. The oscular valves are five in number, composed of rather short radiating spines, forming regular triangular fans, the web which unites them being reticulated in a similar manner to the rest of the dorsal membrane. The valves, when closed, form a prominent pyramidal peak in the centre of the disk. The reticulated dorsal membrane reaches close up to the margin of the lateral fringe.

Ambulacral furrows distinctly petaloid. Ambulacral spines 2, rather short, placed side by side well up in the furrow, and forming a straight line parallel therewith. The spines of a pair radiate slightly apart from one another in the plane of their position; and each is covered with a thick semitransparent membrane, which is somewhat expanded opposite the outer third of the spine, imparting thereby an elongate subspatulate form, the adoral spine of a pair being more robustly so than its companion. Aperture-papillæ small and short, suboval in form on the inner portion of the ray, but becoming more elongate as they recede from the mouth.

Mouth-plates small, with strongly developed ridge at the line of junction, and prominent peak aborally. Each plate bears two short, robust, conical secondary surface-spines, one placed near the adoral extremity, and the other about midway along the ridge; both spines are nearly equal in length, not longer than the ambulacral spines, very wide at the base, and taper to a blunt extremity, faintly bowed outward, and the tip approximated to the tip of the corresponding spine on the companion plate. Mouth-spines 3, small; two situated at the extreme outer portion of the lateral margin, one more inward.

Actino-lateral spines about 24 on each side, 8th or 9th from the mouth longest. The spines anterior to this are included within the disk, their extremities reaching almost, but not quite, up to the median interbrachial line. The succeeding spines diminish in length gradually as they proceed outward, and even towards the extremity remain comparatively long in comparison with those of the other members of the genus. The actino-lateral spines are very robust, and taper slightly to the tips, which project

well beyond the membrane, and give the appearance of a sharply indented margin. The web of the actino-lateral spines, which also forms the ventral floor, is made up of very thickly packed, fine, delicate crossing fibres.

Colour, in alcohol, light brown above, pure white beneath.

Station 286. Lat. 33° 29′ S., long. 133° 22′ W. Depth 2335 fms.; bottom temperature 0°·8 C.; red clay.

HYMENASTER CARNOSUS, n. sp.

Marginal contour substellate; interradial angles well defined, the lesser radius in the proportion of 58·2 per cent.; $R=103$ millim., $r=60$ millim. Radii tapering regularly to the extremity. Dorsal area slightly convex, rising somewhat conoid in the centre, radii rather roundly arched. Actinal area flat or convex. A narrow, thick, fleshy conspicuous fringe surrounds the entire margin.

Supradorsal membrane thick, fleshy, opaque. Paxillæ-spinelets uniformly and closely distributed over the whole area, greatly protruding and covered with membrane, which gives them the appearance of broad-based, robust, conical thornlets, about 3 to 4 millim. in height, springing from the general surface. They are very uniform in size; and no definite order of arrangement is perceptible, nor is it possible to distinguish the individual crowns to which the spinelets belong. A more or less homogeneous muscular layer overspreads the whole area; and no specialized bands or fibres are superficially apparent. The spiracula are quite microscopic, and confined to small round groups, containing ten or more very closely crowded together, placed in the hollow interspaces between the spinelets, and the whole quite invisible to the naked eye. Oscular orifice large, with valves broad and squarely truncate at the extremity, all webbed together; the prominent thorn-like spinelets above mentioned marking out a circle at their bases of attachment 24 millim. in diameter.

Ambulacral furrows wide (8·5 millim.), nearly uniform in breadth until near the extremity, where they gradually converge. Sucker-feet numerous and closely crowded, but maintaining the regular biserial arrangement. Ambulacral spinelets 2, long and needle-shaped, placed side by side in line with the margin of the furrow, or the very slightest trace oblique. The adoral spinelet is somewhat the longest; and both are invested with an extensive saccular membrane, extending beyond the extremity,

often to a length equal to that of the spinelet itself. Aperture-papillæ moderately large, elongate and suboval. A fleshy thickening or pad is developed on the surface that fits over the aperture, upon which it closes like a valve.

The mouth-plates are of moderate size, widely expanded laterally, the keel along the junction being well developed, prominent aborally, and with a rather produced peak adorally. Two secondary surface-spines on each plate—one near the adoral extremity, the other, shorter and more robust, midway on the plate and with wide-flaring investment. It is a question whether the anterior pair ought not, from their position, to be ranked with the true mouth-spines. Mouth-spines proper 3 to 4 in number, acicular, and placed on the margin of the lateral flange.

Actino-lateral spines closely placed, and entirely hidden in the thick fleshy membrane with which the ventral interbrachial areas are uniformly covered. 50 to 60 spinelets on each side of a ray.

Colour, in alcohol—dorsal surface purplish grey, actinal surface pinkish purple.

Station 295. Lat. 38° 7′ S., long. 94° 4′ W. Depth 1500 fms.; bottom temperature 1°·4 C.; red clay.

HYMENASTER GLAUCUS, n. sp.

Marginal contour stellato-pentagonal; interradial angles well indented, forming a distinct angle, except in very large specimens, where the web has become somewhat overgrown and abnormally thickened. Minor radial proportion from 68 to 76 per cent.; R=46 millim., r=35 millim. The rays taper to a fine extremity; and the web is rather full on the margins, and somewhat irregular in consequence. General form very depressed. On the dorsal surface the radial areas are well marked out, distinct from the fringe and interbrachial membrane, by a regular linear arrangement of paxillæ-spinelets, the radial areas being elevated above the general surface. The pseudo-sides of the rays are short and perpendicular; the rays themselves having the appearance of standing in relief above the superficies of the marginal and interbrachial web, tapering to a fine point, and maintaining their distinctness up to the very extremity. The lateral web or fringe is largely developed, and, being rather full, is in consequence somewhat irregular.

Supradorsal membrane with very numerous muscular fibres,

which radiate from the tips of the spinelets and pass to those standing in close proximity around, the bands crossing at various angles, overlying and underlying one other, and forming an interlacing tissue rather than a truly reticulated structure. Spiracula moderately large, irregularly placed, and not numerous. Paxillæ with seldom more than three spinelets, which are usually aggregated close together, and especially so along the median line of the ray and at the extremity, forming a crown of small expansion. Towards the disk the spinelets are more widely spaced; and the paxillæ, which form the pseudo-sides of the ray, are disposed in a perfectly straight line, no stragglers encroaching on the web or interbrachial area.

Oscular aperture large and conspicuous; valves regular and formed of comparatively few spinelets, seldom more than a dozen in each. The outer margin of the oscular ring is very strikingly marked out by short, prominently protruding, pointed spinelets, excentrically directed, very regularly disposed, and from the tips of which the membrane hangs in graceful folds.

Ambulacral furrows moderately broad, sublanceolate in outline, fairly uniform in width, except near the mouth, where they are constricted, and along the outer fifth, where they taper rapidly up to the extremity. Ambulacral spinelets 2, short, acicular, pointed, covered with membrane forming a moderately developed terminal sacculus. In some specimens this appears to be much more developed in the adoral spine of the pair than in the aboral, which seems frequently to be smaller than the other. The aboral spine is also placed higher in the furrow than the adoral. Aperture-papillæ large, and, with their investment, broadly lanceolate or acumino-spatulate in form.

Mouth-plates short and rather broad; aboral prominence blunt and well-rounded. Each plate with two very short, robust, stumpy secondary surface-spines; the adoral one (which is placed forward on the plate) shorter even than the mouth-spines proper, but much more robust. Mouth-spines proper 4 or 5 on each plate, rather long, fine, and nearly equal in length.

Actino-lateral spines robust, well-spaced, the 14th or 15th from the mouth being longest. None meet in the interbrachial median line, not even the longest, the space being filled in with fleshy membrane.

Colour in alcohol—dirty white in large specimens, greenish grey in those of smaller size.

Station 235. Lat. 34° 7′ N., long. 138° 0′ E. Depth 565 fms.; bottom temperature 3°·3 C.; mud.

HYMENASTER VICARIUS, n. sp.

Marginal contour subpentagonal; interradial angles well indented, the lesser radius being in the proportion of 69·2 per cent.; $R=39$ millim., $r=27$ millim. The lateral fringe is more or less distinct; and its margin forms a line that curves outwards after passing the middle of the ray, adding greatly to the appearance of its breadth; the margin then suddenly contracts and emphasizes the rapid tapering of the ray at the extremity.

Supradorsal membrane thin and papyraceous in appearance. Muscular fibres numerous and irregular, rather thick, closely placed, radiating from the tips of each spinelet to those around, and thus forming an interlacing web with moderately large meshes of rhomboid or quadrate form. The interspaces are filled in with transparent membrane, punctured in the centre by a spiraculum; these are moderately large, well-spaced, and uniformly though irregularly distributed over the dorsal area. Paxillæ numerous,—carry 4, 5, or 6 spinelets, which are rather short, pointed—their tips elevating the membrane into small pointed papillæ, which are very evenly spaced over the dorsal area and appear to rise sharply from the surface, whilst their small size and comparative closeness of position give an easily recognizable character to the Starfish.

Ambulacral areas moderately broad, lanceolate in outline, tapering rather rapidly before they reach the extremity, which is in consequence somewhat produced. Ambulacral spines two, rather short, cylindrical and pointed, covered with an extensive investing membrane, which forms an elongate sacculus at the tip, and also adds greatly to the apparent robustness of the spinelets. Aperture-papillæ large, acumino-spatulate, wide and rotund at the base, often contracting rapidly to a point at the free extremity, or simply rounded.

Mouth-plates small, elongate, narrow, keeled, prominent aborally, each bearing two short robust secondary surface-spines, one near the adoral extremity, and the other placed more aborally, near the middle of the plate. The horizontal margins of the plate which fall into the actinostome are expanded into a rather wide flange, upon the edge of which are situated 4 or 5 short

cylindrical mouth-spines, slightly curved, rounded at the tips but not tapering.

Actino-lateral spines delicate, those included within the disk being short and not reaching up to the median interradial line, but leaving a rather wide space. The longest spine is about the fifteenth from the mouth; but even these do not meet in the arm-angle, where a considerable amount of thickening and deformity of the membrane occurs. The tips of the spinelets are rather tapering, and not thickened or nobbed. Margin of the web slightly thickened, not indented or festooned.

Colour in alcohol, white, tinged with yellow where the membrane is thickened in the arm-angles. Sucker-feet yellow.

Station 300. Lat. 33° 42′ S., long. 78° 18′ W. Depth 1375 fms.; bottom temperature 1°·5 C.; *Globigerina*-ooze.

HYMENASTER INFERNALIS, n. sp.

Marginal contour substellate; interradial angles well indented and somewhat angular, the lesser radius being in the proportion of 43 per cent.; $R=28$ millim., $r=12$ millim. approximately. Radii broad at the base, but greatly attenuated outwardly. General form depressed.

Supradorsal membrane very thin. Paxillæ having long pedicels, with 8 to 10 elongate delicate spinelets. Muscular fibres extremely fine and thread-like, rather numerous, radiating from the tips, which are more or less prominent, suggesting the character of the same structure in *H. pullatus*, the fibres, however, being much more delicate and less numerous. Spinelets forming the valves of the oscular orifice rather robust.

Ambulacral furrows narrow. Ambulacral spines 2, long and needle-shaped, placed slightly oblique to the line of the furrow. Innermost aperture-papillæ very large and comb-formed, composed of a number of radiating shafts. Adambulacral plates elongate.

Mouth-plates with prominent and rather angular keel along line of juncture, and bearing two short and moderately robust superficial secondary mouth-spines, the anterior pair close to the adoral margin. Several (three or more) mouth-spines on the margin of the lateral expansions.

Actino-lateral spines short, robust, and placed wide apart, the 6th or 7th from the mouth being longest. Character

along the free portion of the ray indeterminable. Actinal membrane with numerous fine muscular fibres.

Unfortunately this delicate specimen has been so shattered and distorted that its present state of preservation will not admit of a satisfactory description. This difficulty of study is the more to be regretted as the form is one of the deepest-dwelling Asterids obtained during the Expedition. The characters above enumerated are sufficient, however, to indicate that the species under notice is clearly distinct from any other in the group. The attenuation of the rays, the number and delicacy of the paxillæ-spinelets, and the characters of the actinal surface readily distinguish the form. On these grounds I have deemed it advisable to establish the species, although loth to do so on such imperfect material.

Station 244. Lat. 35° 22′ N., long. 169° 53′ E. Depth 2900 fms.; bottom temperature 1°·2 C.; red clay.

HYMENASTER CÆLATUS, n. sp.

Marginal contour stellato-pentagonoid; interradial angles sharply indented, the lesser radius being in the proportion of 63·3 per cent.; $R=30$ millim., $r=19$ millim. The dorsal area is concave, the radii being curved upward and their extremities recurved and quite turned over; actinal area very convex. The radial areas are well marked out, the lateral margins converging gradually to the tip, which is not attenuated or produced. A secondary membrane extending beyond the actino-lateral spines forms a conspicuous fleshy fringe.

Supradorsal membrane rather thick. Paxillæ with 4 to 5 spinelets, forming regular crowns, which elevate the membrane into rhomboid or pentagonal areas, raised in relief as it were, and closely placed, the margins of the tabulæ being more or less incurved, and the interspaces between deep and furrow-like. Muscular fibres closely interwoven, bands ill-defined, and meshes irregular; spiracula small, and frequently two or more together—this structure being uniform over elevated areas and interspaces alike. Tips of the paxillæ-spinelets only slightly protuberant; the relief-areas which fall in the margin of the ray are smaller, more compressed, and somewhat modified in form from the others. About 7 longitudinal rows of elevated areas or tabulæ may be counted at the base of a ray.

Oscular orifice small, circumference at the base of the valves pentagonal, 9·25 millim. in diameter, and marked out by spinelets.

Valves 5, very regularly triangular, apices sharply pointed, all webbed together, the whole forming a regular pyramid when closed. The two innermost spines of each valve stand somewhat apart, and the membrane is rather deeply drawn in between, producing a well-defined furrow along the median line. The projecting tips of spinelets are prominent at the sides of the valves. At the base of each valve are two large elevated areas, formed by paxillæ-crowns of 6–8 spinelets, and thus nearly twice the size of the other elevated tabulæ upon the dorsal surface: they are subpentagonal in shape; and the ten form a conspicuous and well-defined circlet round the oscular pyramid.

Ambulacral furrows rather wide, straight, uniform in breadth, except at the extremity, where they rapidly converge. Ambulacral spines 3, very short, cylindrical, slightly tapering, covered with membrane, placed in line oblique to the furrow. Aperture-papillæ large and subcircular, with its investing membrane somewhat Japanese fan-shaped. The calcareous portion of the papilla is very flaring in habit, sometimes appearing as if made up of a comb of radiating spinelets.

Mouth-plates small, short but broad, with widely-expanded lateral flanges, broadly rounded in front, keel along line of junction feebly developed, aboral extremity only slightly prominent. Two secondary surface-spines borne on slight tubercles, one near the adoral extremity, and the other near the middle of the plate. These spines are short, comparatively small, broad at base, and taper slightly at the tip—the adoral pair being rather the smaller, and not much larger than the ambulacral spines. Mouth-spines 3, similar in size and form to the ambulacral spines, arranged on the lateral margin of the plate and away from the adoral peak of the keel.

Actino-lateral spines widely spaced, the difference in the length being comparatively small along the inner two thirds of the ray. About 27 spines on each side of a ray, the 6th or 7th from the mouth slightly longest. None of the spines meet in the interbrachial median line, but are widely separate; they are covered with a thick fleshy tissue, which is slightly turned over the tips of those spinelets that fall beyond the arm-angle, and is then extended in the form of a fleshy supplementary web or fringe, which is very conspicuous in the arm-angle, and extends up to within a short distance of the extremity of the ray, gradually diminishing in breadth as it proceeds outwards. The margin of

this supplementary fringe is thickened, and furnished with a powerful muscular band.

Colour, in alcohol, a rather livid pink; ambulacral furrows and sucker-feet a yellowish white.

Station 158. Lat. 50° 1′ S., long. 123° 4′ E. Depth 1800 fms.; bottom temperature 0°·3 C.; *Globigerina*-ooze.

HYMENASTER CRUCIFER, n. sp.

Marginal contour subpentagonal; interradial angles very slightly indented, the lesser radius being in the proportion of 66·6 per cent.; $R = 51$ millim., $r = 34$ millim. Radii tapering to a fine extremity, which is somewhat attenuated and produced. Marginal fringe comparatively insignificant as seen from above, and narrowing rapidly towards the extremity of the rays. Form depressed, more convex on the actinal than on the abactinal surface.

Supradorsal membrane rather thin, muscular fibres numerous, thick, and radiating regularly from the tips of the spinelets. Paxillæ numerous, though somewhat widely spaced, bearing a crown of four or sometimes five spinelets, which usually elevate the membrane into slightly raised, Maltese-cross-shaped areas. The spinelets are sharply prominent; and the fibres for a short distance around the tip are merged together and form a homogeneous "cap;" the caps of each of the spinelets of a crown coalesce, and thus produce the subcruciform or rhomboid elevations above mentioned. The paxillæ are well spaced, and are arranged in longitudinal lines along the rays. No spiracula occur on the raised areas; but in the intermediate spaces they are very numerous and closely placed, the intervals between the thick radiating bands being very narrow, and occupied by a great number of small spiracula placed close together in line, 4 to 8, or even more in each, and separated from one another by only the finest dissepiment. The numerous spiracula and the isolated unpunctured cruciform areas give a striking character to the dorsal surface. The oscular orifice is large, the valves all webbed together, and the spinelets quite hidden in membrane, the whole of which is uniformly punctured with a great number of small spiracula, not quite so closely placed as those on the disk, and not arranged in lines.

Ambulacral furrows rather widely petaloid, rapidly constricted at the extremity. Ambulacral spines three, short, nearly uniform in length, pointed, and covered with a membrane expanded into

a lanceolate shape, but with no terminal saccular prolongation. Each series of spines is placed diagonally upon its plate, or oblique to the line of the furrow. Aperture-papillæ large and broadly subspatulate or even subrhomboid, expanded somewhat obliquely, the pedicel seeming to be attached rather on one side.

Mouth-plates rather broad, prominent aborally, having 5 or 6 short mouth-spines attached to the lateral aliform extensions, and directed horizontally. Two short, robust, subconical secondary mouth-spines are borne on the superficies of each plate—one near the adoral extremity, and the other, which is thickest, placed midway between this spine and the aboral extremity of the mouth-plate.

Actino-lateral spines long and well spaced, about 40 on each side of a furrow, the 11th or 12th from the mouth being longest. The spines within the disk do not quite meet in the median interradial line; and those along the outer third of the ray diminish in length very rapidly; they are, however, rather irregular in their length throughout, which gives a ragged appearance to the fringe. The spines are pointed at their extremity; and the web is very slightly indented between.

Colour, in alcohol, yellowish grey.

Station 158. Lat. 50° 1′ S., long. 123° 4′ E. Depth 1800 fms.; bottom temperature 0°·3 C.; *Globigerina*-ooze.

HYMENASTER ANOMALUS, n. sp.

Marginal contour stellato-pentagonal; interradial angles wide and rather sharply and angularly indented, the lesser radius being in the proportion of 63–65 per cent.; $R=15$ millim., $r=9·5$ millim. approximately. Radii subtriangular in outline, and tapering to a fine extremity. Form very depressed, only slightly elevated in the centre of the disk. Marginal fringe quite inconspicuous when seen from above.

Supradorsal membrane with uniformly thick fibrous bands closely reticulated, the network exhibiting a certain incipient regularity of construction. The meshes or interspaces are large and equidistant; and a more or less distinct grouping round centres is distinguishable, where the fibres become massed together—these thickened portions corresponding usually with the tips of the spinelets, upon which they form a cap. Six to eight bands usually radiate from these centres; and if the plan just indicated were regularly carried out, an arrangement of more or less dis-

tinctly hexagonal compound meshes, divided by fibres radiating from their centre, would be produced—one primary mesh around each spinelet, and secondary meshes within this, formed by each of the radiating fibres. This disposition of reticulation, however, is by no means regular, as numerous supplementary meshes and centres occur. The meshes are usually circular, oval, or subtriangular in outline, and are filled in with a fine semitransparent membrane, punctured in the centre with a minute spiraculum, which is surrounded by an opaque whitish ring. The dorsal membrane and its system of reticulated fibres extends almost up to the extreme edge of the lateral fringe. The tips of the paxillæ-spinelets produce slight, uniform, rounded elevations of the membrane, distributed over the whole dorsal area, to which they give a papillose or coarsely granulate appearance when seen by the naked eye. Oscular orifice small, the circumference at the base of the valves being circular and well marked out. The spines of the valves are webbed together by an investing membrane, with reticulated fibres, into five regular, triangular fans, the margins slightly overlapping, and, when shut down, completely closing the oscular orifice.

Ambulacral furrows lanceolate, scarcely, if at all, expanded in the middle, and gradually tapering to the extremity. Ambulacral spinelets 3, short, and placed obliquely—the two outermost standing almost at right angles to the furrow, the innermost, which is slightly smaller, being placed rather in advance of, or aboral to, these latter. The spines are invested with an extensive transparent membrane; and frequently two, or even all the three, are webbed together. When single, the covering gives them a broadly lanceolate shape. The aperture-papillæ are very small and elongately oval in form.

Mouth-plates small, the pair forming a prominent though narrow ridge. Each plate carries three very robust, blunt, secondary superficial spinelets placed in line along either side of the keel, the anterior pair near to the adoral extremity, and the posterior pair near the aboral extremity of the mouth-plate. They differ slightly in size, the adoral being smallest and the aboral largest. On the horizontal margin of each plate are two mouth-spines, the innermost pair immediately above the anterior secondary spinelets, of which series they seem to form the continuation, being directed downwards and centripetally. The aboral pair of secondary spinelets are directed centrifugally. The

second, or outer, mouth-spine is very much smaller, and placed away from the inner mouth-spine, somewhat isolately on the margin of the plate, and is directed horizontally.

Actino-lateral spines about 21 on each side (of fairly large ones only 18), the 6th from the mouth being longest; this and all the spines preceding it join close up in the median interradial line with the corresponding spine of the neighbouring ray, whilst the succeeding spines diminish by regular steps. Spines tapering and pointed. Membrane made up of very fine fibres; margin very slightly festooned between the tips of the spines.

Colour, in alcohol, white; ambulacral furrows and sucker-feet yellowish brown.

Station 335. Lat. 32° 24′ S., long. 13° 5′ W. Depth 1425 fms.; bottom temperature 2°·3 C.; *Globigerina*-ooze. Also off coast of Portugal; label marked 'Station I.–VII.'

HYMENASTER LATEBROSUS, n. sp.

Marginal contour substellate; interradial angles sharply indented, the lesser radius being in the proportion of 63·6 per cent.; $R=22$ millim., $r=14$ millim. Arm-angle acute; rays broad and subtriangular, with their margins gracefully curved outward. General form depressed; dorsal surface over the radii more or less bombous; radial areas not specially defined. Dorsal membrane continuous up to the margin; lateral fringe narrow, regular, and sharply indented.

Supradorsal membrane fine and semitransparent. Paxillæ-spinelets uniformly distributed over the entire area, but presenting no definite order of arrangement. Paxillæ with few spinelets, 4 to 5 being the general number. Muscular fibres numerous and closely, though rather coarsely and irregularly, reticulated (intercrossed). Interspaces filled in with a delicate semitransparent membrane, punctured with spiracula, usually one to a mesh, and consequently rather widely spaced. Oscular orifice comparatively small, the valves lying almost level with the surface of the dorsal membrane.

Ambulacral furrows moderately broad, and subpetaloid in outline, tapering gradually to the extremity along the outer third of the ray, and slightly constricted towards the actinostome. Ambulacral spines 3 in number, short, cylindrical, rapidly tapering to a fine point, and covered with thin membrane. Each series is placed high in the furrow, and very oblique to the median line of

the ray; the aboral spinelet is much smaller than the other two, of which the adoral is slightly the longest. Aperture-papillæ small and oval or subcircular in form, sometimes expanded laterally to such an extent that the breadth is greater than the length.

Mouth-plates comparatively small and short; keel prominent, having a rhomboid outline when seen from above, and inclined upwards into the mouth-cavity, with rather widely expanded lateral flanges, straight and square in front. Each plate bears two robust secondary spines, one on the middle of its surface, standing in the lateral angle of the rhomb, and another, comparatively smaller and thinner, placed near the adoral extremity. Mouth-spines proper are represented by three small tapering spinelets placed on the lateral margin of each plate.

Actino-lateral spines robust and of moderate length, the 7th to 9th from the mouth being longest. The spines of two adjacent rays do not quite meet in the median interradial line, a little narrow channel or wrinkle of the membrane being maintained between their tips. The spines diminish regularly in length after the angle is passed, until they become microscopic at the end of the ray; they are pointed at their outward extremity; and the web being well indented between gives a serrate appearance to the margin.

Station 157. Lat. 53° 55′ S., long. 108° 35′ E. Depth 1950 fms.; diatom-ooze.

HYMENASTER POROSISSIMUS, n. sp.

Marginal contour subpentagonal; interradial angle scarcely indented, forming simply a slight curve inward. The lesser radius is in the proportion of 75·5 per cent.; $R=45$ millim., $r=34$ millim. The radii do not taper beyond the extent of a true pentagon, and are slightly rounded at the extremity, which is somewhat feebly upturned.

Supradorsal membrane very uniformly reticulated; the muscular fibres so closely and regularly placed that their radiation from the spinelet-tips as centres is scarcely apparent; meshes very small and regularly spaced, each with one small spiraculum. Paxillæ-spinelets 3, 4, or 5 in number, evenly spaced, rounded at the tips, very slightly prominent, and producing a uniformly papillate appearance on the dorsal area, no general pattern of arrangement being discernible. The crowns of a great number of the paxillæ

form a more or less distinctly visible Maltese cross, in consequence of two prominent fibres joining the tips of the opposite spinelets. Oscular orifice moderately large; circumference at the base of the valves very clearly marked out by prominent spinelets. Valves triangular, 5 in number, forming a regular pyramid; the whole series webbed together with a membrane closely punctured with spiracula like the rest of the dorsal area, and with 2 or 3 prominent spinelets projecting along the sides of each valve.

Ambulacral furrows rather wide, subpetaloid, or gracefully lanceolate. Ambulacral spines 3, short, delicate, slightly tapering, nearly equal in length, covered thinly with membrane, but with no saccular extension present. Each series placed slightly oblique to the median line of the ray. Aperture-papillæ large and squarely oval, with a thick plump sacculus, and attached close up to the outer extremity of the diagonal series of ambulacral spinelets.

Mouth-plates very elongate and remarkably narrow, the pair together forming a prominent, elevated, rounded ridge, tapering and roundly pointed at either extremity. Near the adoral extremity of each plate stands a single, rather large spine, subconical, becoming attenuated towards the extremity, but not pointed. These spines are directed horizontally over the peristome, the pair in each mouth-angle diverging slightly apart from one another and away from the median line of the mouth-plates; these are the anterior pair of secondary mouth-spines, placed unusually forward. From the superficies of each mouth-plate, and about one third from the inner or adoral extremity, rises a second, robust, subconical, and moderately long spinelet, directed downwards and slightly inwards. Both these pairs of secondary superficial spinelets are about equal in length to the ambulacral spinelets, but are more robust, the aboral being stouter but rather shorter than the companion pair. Mouth-spines 4 or 5, short, subcylindrical, thickened at their bases, placed on the margin of the plates, and directed horizontally. These spines are much smaller and shorter than the secondary superficial spines above noted, and are attached to a wide lateral extension or flange of the mouth-plate.

Actino-lateral spines long and rather widely spaced, the longest about midway out on the ray (the eleventh from the mouth); about 40 in all. The spines within the disk come nearly up to the median interradial line, but do not meet. The spines whose free extremities fall in the marginal fringe diminish gradually

and with regularity up to the extremity, the few last maintaining, however, a nearly uniform length, which gives a rounded appearance to the fringe at the ray-tips. The actino-lateral spines are finely pointed at their extremities; and the web-membrane is moderately indented between them. The marginal fringe is perfectly even and regular, forming a conspicuous marginal border when seen from the upper suface, although the reticulated dorsal membrane is continued close up to the margin.

Colour, in alcohol, greyish white.

Station 300. Lat. 33° 42′ S., long. 78° 18′ W. Depth 1375 fms.; bottom temperature 1°·5 C.; *Globigerina*-ooze.

Hymenaster graniferus, n. sp.

Marginal contour almost pentagonal, the interradial angles being very slightly incurved. The radii are more or less attenuated or produced at the extremity, which is upturned; and their effect on the contour is consequently inconspicuous. Minor radial proportion about 69–73 per cent.; $R=30$ millim., $r=22$ millim. Radial areas not specially defined externally from the rest of the dorsal surface. Lateral fringe or web thickened at the margin and little conspicuous.

Supradorsal membrane delicate. Paxillæ-spinelets delicate, with fine sharp extremities protruding well through the dorsal membrane, evenly distributed over the area, but presenting no definite pattern of arrangement. The fibrous bands are rather thin but clearly defined, comparatively few in number, well isolated, and radiate not only to those spinelets which form the immediate circle, but some also pass through the interspaces and reach to the spinelets beyond. In this manner a more or less irregular and very open network is produced, in which, however, a tendency to an interpenetrant hexagonal pattern is discernible as the general plan, here and there—the whole being overlain by a very delicate semitransparent membrane, in which a number of small, round, closely-placed granule-like bodies occur. The spiracula are small and sporadically placed, very frequently two or even three together in a mesh; but the groups are well isolated, and the apertures by no means numerous. Oscular orifice large, with 5 regular valves fitting evenly together, each with about a dozen spines, the two innermost being longest, and the others diminishing regularly and gradually, the articulatory base being prominent.

Ambulacral furrows narrow, much constricted towards the actinostome and at the extremity of the ray. Ambulacral spines 3, acicular, unequal in length, rather short, placed in line parallel to the median line of the furrow, excepting towards the extremity, where the series become rather oblique. The aboral spine is almost aborted, and the middle one less than the adoral spine of the trio; this latter is invested with a widely expanded sacculus, which makes the spine appear many times thicker than its companion and nearly twice as long, the large sacculus usually taking a pointed or sublanceolate form, whilst the small investment of the aborted aboral spine is generally rounded and somewhat knobbed. The aperture-papilla is remarkably large, elongately oval, and with its membrane acumino-spatulate in shape, much broader than the sacculated ambulacral spinelets, and often nearly as long.

Mouth-plates short and comparatively broad, with widely expanded lateral flanges. No prominent keel at the line of junction, which is flatly rounded. Two robustly clothed, rather short, obtuse secondary surface-spines on each plate, one near the adoral edge, the other near the middle of the plate, both maintaining a wide space between their corresponding spines on the adjoining plate. About four mouth-spines proper on the horizontal margin of each plate, moderately long, very wide at the base, and sharply tapering; the external one sometimes reduplified.

Actino-lateral spines delicate, well spaced, the longest about *15th from the mouth; none meet in the interradial line, but are* widely separate even at the angle; the spines vary but little in length up to this point, but diminish very rapidly beyond.

Colour, in alcohol, white.

Station 146. Lat. 46° 46′ S., long. 45° 31′ E. Depth 1375 fms.; bottom temperature 1°·5 C.; *Globigerina*-ooze.

HYMENASTER GEOMETRICUS, n. sp.

Marginal contour substellate; interradial angles well rounded, the lesser radius being in the proportion of 52·3 per cent.; $R=42$ millim., $r=22$ millim., approximately. Radii greatly attenuated and tapering, with the fringe almost, if not quite, aborted towards the extremities. Dorsal surface uniformly flat; under surface prominently convex.

Supradorsal membrane thin and semitransparent, supported

by extremely delicate thread-like fibres, which form a regular pattern upon the disk. Usually six fibres proceed from the tip of each paxilla-spinelet, and pass to the tips of the neighbouring spinelets; and as these are all equidistant, it follows that a series of regular interpenetrant hexagons is produced. The fibres are all of uniform length, and do not cross over or under one another as in *H. pullatus*. The spaces marked out or bounded by the fibres form regular triangular meshes, and enclose several small spiracula, generally 3 to 5. Sometimes the fibres are doubled, and the tips of the spinelets protrude prominently.

The valves of the oscular orifice are not conspicuous, the general tissue of the dorsal area just described seeming to be continued up to the extremities of the valves, whilst their bases of attachment, which are usually well marked out by spinelets on prominent bosses, are undistinguishable in the present example.

Ambulacral furrows rather narrow, not petaloid. Ambulacral spines 3, long and needle-shaped, placed in line parallel with the median line of the ray; the adoral spine longer than the breadth of the furrow.

Aperture-papillæ of moderate size, subquadrate or rather elongate in shape, when invested with membrane.

Mouth-plates short, with wide lateral flanges; the keel along the line of junction very prominent aborally. Mouth-spines 5 to 6 on each plate, moderately long and subaciculate, the middle one longest; the innermost one ought perhaps to be ranked as a secondary or superficial mouth-spine, although similar in form and serial in position with the true mouth-spines. Midway on the superficies of the plate and well away from the median keel is a longer and slightly more robust secondary spinelet, similar in character to the rest of the armature.

Actino-lateral spines very wide apart, probably not more than 20 on a side, although the rays are so long, the 4th or 5th from the mouth being longest; these and the preceding spines, which are included within the disk, all converge towards the interradial angle, instead of running parallel to one another as in nearly all the species of this genus.

Station 286. Lat. 33° 29′ S., long. 133° 22′ W. Depth 2335 fms.; bottom temperature 0°·8 C.; red clay.

HYMENASTER PULLATUS, n. sp.

Marginal contour more decidedly stellate than pentagonoid.

The interradial angles appear to have been well rounded, with the lesser radius probably in the proportion of about 57 per cent.; R=35 millim., r=about 20; but the specimen is unfortunately so much damaged in each of the arm-angles that it is impossible to give the smaller dimension exactly. Radii well produced, fine and tapering at the extremities. Dorsally the centre of the disk is elevated into a sharp conoid, and the radii are prominently arched.

Supradorsal membrane very delicate. Spinelets of the paxillæ prominently projecting, very delicate, and tapering towards their extremity, distributed regularly at uniform intervals apart over the whole dorsal area. Numerous very fine thread-like fibrous bands pass between the tips of the spinelets, crossing over and under one another, but not merging or forming a coherent reticulated structure. The fibres are not tightly stretched between the tips of the spinelets, but slope downward at a high angle, like slackened ropes round a tent-pole; in consequence of this and of their great prominence, the spinelets appear to superficial examination to stand like well-spaced conical prickles upon the dorsal area. The oscular orifice is of moderate size, the outer margin (from which the valves take their rise) being marked off by prominent sharp spinelets into a pentagon, 9·5 millim. in diameter, the angles opposite to the radii. The valves are very regularly subtriangular, composed of 10 to 12 radiating spines, and when closed form a pyramidal peak in the centre of the disk.

Ambulacral furrows narrow and deeply sunken, constricted near the mouth, widest about the outer third, and then sharply tapering to the extremity. Ambulacral spinelets 3, short, stout, tapering, compressed, placed in line oblique to the direction of the furrow and also to the horizontal plane of the ray. The ambulacral spines are quite hidden in the furrow, not webbed together, but probably invested with a rather long membrane. Aperture-papillæ large and squarely oval.

Mouth-plates somewhat broad, short, almost perpendicular in position; keel flattened. Each plate bears two short thick secondary superficial spinelets, the aboral one most robust. One mouth-spine stands above the innermost secondary; and another, much smaller, is placed isolately on the horizontal lateral margin of the plate.

Actino-lateral spines 27+, perhaps about 30, robust at the extremity of attachment, but very delicate and taperin outward, not meeting in the interradium.

Colour, in alcohol, dark purple; the fibrous bands on the dorsal surface being white, giving a very elegant effect. The suckers very dark purple, almost black, with white tips.

Station 218. Lat. 2° 33′ S., long. 144° 4′ E. Depth 1070 fms.; bottom temperature 2°·1 C.; *Globigerina*-ooze.

HYMENASTER MEMBRANACEUS, *Wyville Thomson*.

Hymenaster membranaceus, *Wyv. Thoms.* (1877), *Voy. of 'Challenger,' Atlantic*, vol. i. p. 108.

Marginal contour subpentagonal; interradial angles wide and flat, the lesser radius in the proportion of 62 per cent. or less; $R=$ 35 millim. approximately, $r=22$ millim. Radii very narrow, and tapering on their outer portions. Dorsal area almost flat, actinal slightly convex, but deeply incurved along the median interbrachial lines.

Supradorsal membrane thin and transparent, with a great number of fine muscular fibrous bands extended between the tips of the paxillæ-spinelets, passing from one to each of these in the vicinity and crossing one another in all directions, but without merging or forming a reticulated tissue in the true sense of the word. Tissue semitransparent, with a few isolated spiracula here and there. The tips of the spinelets produce slight prominences but there is no massing of the tissue or the fibres upon their extremities, which are consequently quite sharp and little conspicuous. Oscular orifice very large, the outer or basal circumference measuring 12·5 millim. in diameter. Each valve is composed of at least ten radiating spines, their bases of articulation forming a prominent semicircular boss in each radius.

Ambulacral furrows narrow and deep, scarcely petaloid although much narrower near the mouth and rapidly tapering at the extremity; adambulacral plates high Ambulacral spines 3, very short, stout, slightly tapering and slightly compressed, placed high in the furrow, and each series standing in line slightly oblique to the median line of the ray, and oblique also to the horizontal plane of the furrow, the innermost spine being highest up in the furrow and most aboral. Not webbed. Aperture-papillæ very large, covered with widely expanded membrane, giving them a squarely oval or subquadrate shape, often with a slight peak.

Mouth-plates rather small, sloping upward into the mouth, aboral extremity tilted downward, prominent keel along the line

of junction, internal peak rounded and very little produced. Each mouth-plate carries two secondary superficial spines—one short, dumpy, obtuse, compressed, standing on the surface of the plate at about one third the distance from the adoral extremity, and directed somewhat outwards and away from the mouth; the other, rather longer but much less robust, placed quite at the adoral extremity and rather geniculated sideways; in fact this spinelet might almost be ranked as a mouth-spine proper, except that it stands at a slightly lower level, more on the plate itself. On the horizontal margin of the plate, and situated on the widely expanded lateral flange, are 4 to 5 small compressed mouth-spines, very much smaller than those just described, and similar to the ambulacral spines, only smaller in size.

The actino-lateral spines, although long, do not meet in the interradium; indeed the dorsal and ventral membranes coalesce, apparently normally, in the outer portion of the median interradial line, thereby forming a partition in the interbrachial chamber. The spines which come near the interbrachial margin are much thickened and knobbed at their extremity; indeed all of them are more or less so except the most outward of all. There are about 32 to 36 actino-lateral spines, the 15th to 17th from the mouth being longest; beyond this they diminish very rapidly in size.

Colour, in alcohol, white.

Station I. Lat. 41° 57′ N., long. 9° 42′ W. Depth 1125 fms.; *Globigerina*-ooze.

HYMENASTER COCCINATUS, n. sp.

Marginal contour stellato-pentagonoid, interradial angle well rounded; radii tapering to a fine point, with lateral margins almost straight. Minor radial proportion 55·5 per cent.; $R=18$ millim., $r=10$ millim. Form very depressed, slightly convex and rising in the centre. No definite marginal fringe.

Supradorsal membrane very fine; muscular fibres thin, filiform and well defined, forming a rather wide and irregular reticulation, resembling to a large degree the venation of certain leaves more than the characteristic intercrossing of fibres radiating from neighbouring spinelets which is generally noticeable throughout the genus. This peculiarity arises from the frequent bifurcations, bendings, and sudden terminations to which the fibres are subject, and which, together with the presence of small secondary

fibres, modify the normal arrangement of radiation from tip to tip, which is, after all, the principle of the disposition of this structure even in the species under notice. The meshes are filled in with an almost hyaline tissue, punctured with two, three, or even more small spiracula, each surrounded with a definite white ring. The spinelets of the paxillæ are not numerous, and are but slightly protuberant, the tips being covered with a little cap of membrane which gives them rather a knobby appearance. The oscular orifice is moderately large, its outer circumference at the base of the valves being well defined by a pentagonal outline formed of thickened or fibrous tissue. The five valves are regular and triangular, with about 8 spines in each; and the whole series are webbed together and form a very slightly elevated pyramid when closed.

Ambulacral furrows wide and open, very slightly petaloid opposite the commencement of the outer third, and rather rapidly constricted towards the tip. Ambulacral spines 4 (but often towards the extremity only 3), short, delicate, acicular, and well spaced. Three stand on the margin of the plate parallel to the furrow, the aboral smallest, the adoral nearly twice as long. The fourth spine—equal in length to the last named, or even longer—is placed close to it, but on the outer side and away from the furrow. These two spines are present throughout the ray, and maintain this position. The three marginal spines usually stretch horizontally over the furrow; but the fourth spine is almost perpendicular, frequently radiating at an angle away (outward) from the furrow. The spines are covered with an investing membrane, which in the three marginal spines is expanded towards the tip and gives them a claviform appearance, the most adoral one of the three being more robust than the others; in the fourth or outward spine the investment is even more developed, and the covered spine presents a somewhat more lanceolate shape than those just referred to. The aperture-papillæ are very singular in form, and consist of a comb of about 5 to 7 radiating spinelets which spring from a common base, the central spinelet being straight and much longer than the others, which are curved, the two outer ones forming together a regular semicircular span, and the rest radiating within this curve, at gradually lessening angles of divergence from the central spinelet. The investing membrane by which the papilla is covered owes its form in a great measure to this skeleton. It is ovate or oblate

basally, with an elongate acicular prominence in its outward prolongation. Near the extremity of the ray this central shaft of the papilla is greatly lengthened, being little shorter than the lateral spines.

Mouth-plates short but extraordinarily broad, the lateral flanges being developed to an abnormal extent. The keel at the junction is feebly represented, only flatly rounded, slightly prominent aborally, adoral peak well developed. One moderately robust, short, conical spinelet, very wide at the base, sharply pointed, and covered with membrane, is placed near to the adoral extremity of each plate and rather above the actual margin. No other secondary surface-spine present. Mouth-spines 3, about equal in size to the ambulacral spines, placed on the extreme outer portion of the margin of the lateral flange; and sometimes the outer one is doubled.

Actino-lateral spines delicate and well spaced, 16 on each side of a ray, the third or the fourth from the mouth usually the longest, the rest gradually diminishing in size as they approach the extremity of the ray.

Colour, in alcohol—dorsal surface white with the faintest shade of pink, actinal surface scarlet, the suckers white.

Station 146. Lat. 46° 46′ S., long. 45° 31′ E. Depth 1375 fms.; bottom temperature 1°·5 C.; *Globigerina*-ooze.

HYMENASTER PRÆCOQUIS, n. sp.

Marginal contour subpentagonal, interradial angles very feebly incurved, the radii slightly attenuated at their extremity. Minor radial proportion 65 per cent.; $R=10$ millim., $r=6{\cdot}5$ millim. The dorsal surface forms a uniform convex curve of low elevation, the membrane arching over from margin to margin, and the radial areas being in no way specially defined externally. No lateral fringe. Actinal surface flat.

Supradorsal membrane very fine and semitransparent. Muscular tissue very feebly developed, no definite series of fibrous bands being present, although under considerable magnification the existence of aggregated fibres may be discerned. Spiracula comparatively large, numerous and equally distributed, with conspicuous white ring. Paxillæ large, robust, closely placed, usually with five (sometimes six or seven) spinelets, which are thick and widely expanded from the pedicel. The spinelets do not taper at their extremities, but expand somewhat and are flaring, elevating

the membrane very slightly. The paxillæ are clearly visible through the transparent membrane; and about nine longitudinal rows may be counted across the base of the ray. The oscular orifice is small, with the spines of the valves long and slightly tapering.

Ambulacral furrows narrow, lanceolate, maintaining a nearly uniform breadth till near the extremity. Ambulacral spines 3 to 5 in number, rather long, delicate and acicular, arranged on the adambulacral plate in a semicircular curve when the larger number are present—three usually being on the margin of the furrow, and the two adoral ones standing successively more outward (away from the furrow) on the plate. These two obliquely placed spinelets maintain their position throughout the ray; and any diminution which takes place in the number towards the extremity is manifest in the marginal or aborally placed members of the series. The most aboral spine is rather shorter than the others, which are nearly uniform in length; and each of them is invested with a very thin membrane, and no sacculus is produced. The first adambulacral plates (nearest the mouth) bear only two spines; and these sometimes are webbed together.

The aperture-papillæ are small and dumpy, the calcareous portion being little more than twice (or at most three times) as long as broad; and very frequently this is bulged out somewhat at the side. The papilla is not free as usual in this genus, but is clothed with the general tissue of the actinal area, the aboral lateral margin alone being free and forming the actual lip of the segmental aperture as in *Pteraster*; the papilla fits close up to the spine, aboral to it, and slants rather obliquely in consequence.

The mouth-plates are small, short, narrow, both plates elevated prominently rather than forming a true keel at the junction; aboral extremity gently rounded, not prominent. Each plate bears two large, robust, conical secondary superficial spinelets, longer than the plates themselves, tapering to a fine point, and their bases occupying nearly the whole of the length of the short plate. These spines stand perpendicular to the superficies, the aboral pair radiating rather wider apart and more outward than the adoral pair. Mouth-spines 2 (or 3 ?), delicate, pointed, rather wide apart, and placed on the lateral margin of the plates opening into the peristomial circle.

Actino-lateral spines comparatively robust and well spaced, 16 to 17 on each side of a ray, the fifth from the mouth being

longest; they are slightly tapered at their extremity, and just protrude beyond the margin, which is feebly festooned between.

Colour, in alcohol, greyish white, nearly transparent.

Station 146. Lat. 46° 46′ S., long. 45° 31′ E. Depth 1375 fms.; bottom temperature 1°·5 C.; *Globigerina*-ooze.

Station 147. Lat. 46° 16′ S., long. 48° 27′ E. Depth 1600 fms.; bottom temperature 0°·8 C.; *Globigerina*-ooze.

In a specimen from Station 147 four seems to be the normal number of ambulacral spinelets, the adoral one being relatively smaller, and the transverse tendency of the series upon the plate being even more marked than in the specimen from which this description is taken. In this specimen (from Station 147) an additional pair of superficial secondary mouth-spines is present, making three pairs, and the innermost pair of mouth-spines proper are nearly as large as the adoral pair of secondaries.

BENTHASTER, n. gen.

Form depressed, marginal contour stellato-pentagonoid, dorsal area convex, actinal area plane. Supradorsal canopy rudimentary. No muscular fibrous bands. No spiracula. Nidamental cavity more or less aborted. Paxillæ with subfascicular crowns; spinelets trilaminate, of extraordinary length, delicacy, and number, protruding the greater portion of their length naked beyond the supradorsal membrane. Paxillæ probably devoid of investing membrane. Papulæ simple globular sessile sacs, comparatively large. Special dorso-lateral plates at the extremity of the rays. Ossicles of the dorsal surface cruciform, greatly attenuated; the whole calcareous framework being reduced to a minimum. Ambulacral spinelets one or two, long, needle-shaped, independent, not united by membrane. Aperture-papillæ more or less modified. (?) Segmental apertures aborted. Mouth-plates of the *Hymenaster* type. Two pairs of secondary mouth-spines, robust, clavate, thorny, probably without saccular membrane. Mouth-spines proper 2 or 3, the innermost resembling the anterior pair of secondaries, only rather smaller, the others pointed. Actino-lateral spines merged in the actinal floor.

The superficial aspect of this genus recalls, to a certain extent, that of *Korethraster*, from which, however, it is structurally widely separate. The rudimentary supradorsal membrane and the long fasciculated naked paxillar spinelets, protruding far beyond the membrane, readily characterize the genus from *Hymenaster*; whilst the simple, independent ambulacral spines, not forming combs and not webbed, at once distinguish it from *Marsipaster*, the only other form to which it can be compared.

BENTHASTER WYVILLE-THOMSONI, n. sp.

Marginal contour substellate; rays broad at base, and tapering to a very fine extremity; interradial angle well indented, not rounded; the lesser radius in the proportion of 50 per cent.; $R=18$ millim., $r=9$ millim. General body-profile much depressd, slightly elevated in the centre of the disk.

The dorsal aspect is very remarkable, recalling at first sight the appearance of *Korethraster*. This resemblance, however, is merely illusory, and arises from the presence of prominent tufts of long spinelets that project free beyond the dorsal membrane. The pedicels of the paxillæ are comparatively short, reduced almost to tubercles on the outer part of the rays, bearing about 8 to 10 spinelets, which are of great length and expand very slightly apart from one another. Paxillæ standing on cruciform ossicula, the prolongations of which are very long and thin, and the central portion where they cross little, if at all, widened.

Supradorsal membrane represented by a loose irregular spongiform tissue, which fills up the paxillæ-crowns near their bases, and extends over the whole dorsal area. This spongy mass is not uniform in thickness or density, and nowhere forms a definite membrane. The paxillæ-spinelets protrude a great portion of their length through this tissue, and have the appearance of being entangled amongst it—a conventional definition of their character expressing more than any rigid description of this part of the structure. No muscular fibrous bands, and no spiracula present. The spinelets are transparent and vitreous in appearance, regularly trilaminate (which may be distinctly seen in every broken section), and taper to a fine sharp point. No trace apparent of any true membranous envelope to the paxillæ. The spinelets on the disk are much longer and more robust than elsewhere, attaining their greatest size in the neighbourhood of the centre. Oscular orifice rather indistinct, margined by five somewhat irregular tufts of spinelets, longer and more robust than any of the others. No definite or regular valves appear to be formed. It is doubtful to what extent the dermal chamber is developed; but probably its character is greatly modified: the specimen under notice leads to the inference that it is almost aborted in the present instance.

At the extremity of the rays there is on either side an elongate dorso-marginal plate, equal in length to about 7 or 8 segments of the ray, becoming thicker at the aboral end and

developing more or less of a knob. These expansions join at the extremity of the ray, and form an arch over the termination of the ambulacral furrow, the knobs bearing several prominent spinelets stouter than any of those in the vicinity.

Ambulacral furrows broad and rather petaloid. Sucker-feet arranged in simple pairs. Adambulacral plates very narrow and spaced widely apart, the margin of the furrow being simply a narrow ridge. Ambulacral spines normally two, placed transversely and very slightly oblique; but frequently only one is present. They are long, thickened at the base, tapering to the point; and when two are present, the outer one is often much larger than its companion. No trace of any investing membrane. Squamous plates are present on the outer margin of the adambulacral plates, which doubtless are the representatives of the aperture-papillæ. They seem to be more or less aborted functionally in the specimen under notice, and are apparently ankylosed, at any rate on the inner half of the ray, to the general body-skeleton; they are large, and broadly oval or subspatulate in shape.

The mouth-plates resemble in character those of *Hymenaster*. Median keel along suture very prominent adorally and sharply rounded. Two short, robust, curved, slightly clavate, and rather thorny spinelets stand on either side of the keel near the middle of the plates. Owing to the bad state of preservation of this specimen, the rest of the armature is unfortunately undistinguishable.

Actino-lateral spines 15 to 20, or perhaps rather more; comparatively short, delicate, and widely spaced; the longest about fourth from the mouth, and rather shorter than the breadth of the ambulacral furrow, measured from the base of this spine to the base of its correspondent on the opposite side. The actino-lateral spines do not diminish very rapidly in length as they approach the extremity. A fibrillar tissue of very loose construction forms the web uniting the spines, and at the same time constitutes the actinal floor of the test, beyond the margin of which the spines project considerably. In places where the actinal web has been removed in the interradial space, no papillæ are to be seen for supporting the pseudo-supradorsal membrane from the sides of the rays, the cavity appearing to be very feebly developed there.

Station 244. Lat. 35° 22′ N., long. 169° 53′ E. Depth 2900 fms.; bottom temperature 1°·2 C.; red clay.

Benthaster penicillatus, n. sp.

Marginal contour stellato-pentagonoid; interradial angles moderately indented and well rounded. Minor radial proportion 65·2 per cent.; $R=11·5$ millim., $r=7·5$ millim. The radii taper gradually, and their extremities are somewhat upturned.

Supradorsal membrane exceedingly delicate and rudimentary, appearing little more than a thin mucous film over the interbrachial areas, becoming, however, rather spongiform over the rays. Pedicels of the paxillæ very thin and delicate, bearing a crown of extremely long, thin, needle-like spines seven or eight times the length of the pedicel; about 20 spinelets in a crown on the disk, and about half that number, or less, towards the extremity of the rays. The spinelets are of the most delicate description, vitreous in appearance, trilaminate, the transverse section representing three cylindrical rods placed together, instead of three flattened laminæ as in the previous species. The spinelets are widened at their proximal extremity into a condyloid articutory base, all fitting close together, each moulded to the form of its fellows, the whole forming a compact basement to the crown. The spinelets constituting a crown expand very slightly apart, and protrude the greater portion of their length free and naked through the supradorsal membrane.

The cruciform ossicles of the dorsal surface upon which the paxillæ are borne are very delicate, the prolongations being attenuated in a remarkable degree, here and there almost aborted, and the central portion of the ossicle manifesting a tendency to become rotund and squamiform. This modification is so far carried out, that in the centre of the disk the whole of the dorsal surface that can be seen under the oscular orifice is simply covered with subcircular imbedded scales.

The oscular orifice is very large. The valves (or their representatives) consist of a compressed paxilla-crown composed of rather more robust spinelets than the rest. The pedicels of these modified paxillæ are very much enlarged, compressed laterally, and expanded at the top, upon which the spinelets are articulated in a more or less regular double row, the pedicels standing in the median radial line. Powerful muscular bands run between the bases of the pedicels of the valves and form a regular pentagon, near the centre of which the periproctal aperture is situate. Close to the periproct and less than its own breadth away is the remarkably small, round, insignificant, madreporiform body.

The papulæ are simple round sacs, as broad as long, and immensely large in proportion to the pedicels by which they stand.

Dorso-marginal plates are present at the extremity of the ray, and form a terminal arch or ocular guard; but they are not half the length of the similar pieces in the preceding species.

Ambulacral furrows wide, not petaloid; margins of the furrow very narrow. Ambulacral spines 2 or 3, placed very obliquely, the inner or aboral spine the smallest; whilst the outermost spine is probably the representative of the aperture-papilla, of which it occupies the place, although it differs in no way from the other two spinelets; sometimes a small additional spinelet is present. The spines are long, delicate, and needle-shaped; and there are traces of a fine investing membrane.

The mouth-plates are of the *Hymenaster* type, and present a prominent peak aborally, sloping adorally, and little prominent in front. Each plate bears two, long, clavate, thorny, somewhat curved secondary surface-spines, nearly equidistant from one another and from the extremities, and rather wide away from the keel or median suture, the posterior spinelets being longest. Two mouth-spines proper are situated on the horizontal margin of each plate, the innermost one being slightly smaller than the anterior secondary (surface) spine, which it resembles exactly both in form and character; whilst the outer spinelet is very much smaller, and slightly tapering and smooth, instead of being clavate and thorny.

Actino-lateral spines delicate, rather widely spaced, about 15 on either side of a furrow, the 4th or 5th from the mouth being longest. The spines diminish slowly in size as they proceed outward, and maintain a fair length even at the extremity of the ray. The actinal membrane is perfectly transparent, and composed of very fine and widely spaced fibres, reticulated ather rectangularly. No marginal fringe is formed; and the actinal tissue appears to pass over the margin continuous with the dorsal tissue. The actino-lateral spines project considerably beyond the margin, and are naked.

Colour, in alcohol, greyish white.

Station 218. Lat. 2° 33′ S., long. 144° 4′ E. Depth 1070 fms.; bottom temperature 2°·1 C.; *Globigerina*-ooze.

MOLLUSCA OF H.M.S. 'CHALLENGER' EXPEDITION.—Part XI.

By the Rev. ROBERT BOOG WATSON, B.A., F.R.S.E., F.L.S.

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Fam. PLEUROTOMIDÆ

(continued from Vol. XV. p. 475).

PLEUROTOMA, *Lam.*

65. *Pleurotoma* (*Drillia*) *exsculpta*, n. sp.
66. *P.* (*D.*) *tholoïdes*, n. sp.
67. *P.* (*D.*) *amblia*, n. sp.
68. *Pleurotoma* (*Drillia*) *aglaophanes*, n. sp.
69. *P.* (*D.*) *lophoëssa*, n. sp., with var. *platia*.
70. *P.* (*Clionella*) *quadruplex*, n. sp.

These six species, of which the description follows, have fallen out of place from the difficulty of deciding where they should go. After much and contradictory advice, they are classed here tentatively. In all of them the style of the shell is rather that of a *Pleurotoma* than of any thing else; but they can hardly be said to have a labral sinus.

65. PLEUROTOMA (DRILLIA) EXSCULPTA, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. North of Culebra Island, St. Thomas, Danish W. Indies. 390 fms. Coral-mud.

Shell.—High, narrow, conical, scalar, ribbed, with a short conical base, a bluntish apex, and having the colour of thin pale flint. *Sculpture.* Longitudinals—on the last whorl there are about 20 (on the first regular whorl about 12) narrow rounded ribs, which originate in the suture; just below this they rise into little rounded tubercles; at the periphery they project in larger and slightly elongated tubercles, below this point they incline to the right, become feebler on the base, and disappear on the snout: the lines of growth are fine, but irregular and somewhat indistinct. Spirals—below the suture a slight rounded thread connects the costal tubercles; at the peripheral row of tubercles is a keel; feeble, remote, rounded threads appear on the whole surface, becoming

stronger on the base, and still more so on the snout. *Colour* that of pale flint when seen in thin flakes. *Spire* high, narrow, conical, scalar. *Apex* consists of $1\frac{1}{2}$ embryonic whorls, which form a blunt, smooth, small top, with the extreme tip somewhat immersed; these whorls are very finely, but not quite regularly, microscopically spirally scratched. *Whorls* nearly 9, rather short, with a drooping shoulder and a blunt carination, from which they contract with a scarcely convex profile to the lower suture; the base is conical, very lop-sided, scarcely convex, and prolonged into a very short snout. *Suture* sharp and well-defined by the swelling of the whorl above, and by the row of tubercles round the top of the whorl below. *Mouth* oblong, a little oblique, pointed above, prolonged into a shortish oblique canal below. *Outer lip* well arched, with a very slight and open sinus above. *Inner lip*—a very thin glaze runs across the concave line of the body and down the pillar, which is obliquely cut off in front and has a twisted and slightly patulous inner edge. H. 0·65. B. 0·21. Penultimate whorl, height 0·11. Mouth, height 0·25, breadth 0·1.

In general form this species is slightly like a large *Pleurotoma cerinum*, Stimp. and Kurtz, but is obviously quite distinct. It is a good deal like *P.* (*D.*) *tholoïdes*, Wats., but is more scalar, is smaller in the apex, longer in the base, and different in sculpture.

66. PLEUROTOMA (DRILLIA) THOLOÏDES, n. sp. (θολοειδής, dome-shaped, see the apex.)

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—High, narrow, conical, ribbed, strong, with a rather short conical base, a very blunt dome-shaped apex, and having the texture and colour of flint. *Sculpture.* Longitudinals—there are on each whorl about 17 not very distinct, narrow, slightly swoln ribs, which are a little convex backwards; they run from suture to suture, but die out on the base, and toward the mouth they become a little crowded and indefinite; besides these there are a great many fine, regular, hair-like lines of growth. Spirals—there is on each whorl, above the middle, an angulated carination, bearing a thread on its top, which rises into rounded low tubercles where it crosses the ribs; below this, a little above the middle, is another thread, finer, less prominent, and with feebler tubercles, which also marks a slight keel; three other threads of about the

same strength as this last, and at very nearly equal distances, appear on the base: there are faint indications of others besides, as also of microscopic scratches. *Colour* like pale flint in thin flakes; but the apex is white. *Spire* high, narrow, conical. *Apex* consists of $2\frac{1}{4}$ embryonic whorls, which form a blunt, smooth, round dome, with the extreme tip immersed but not hid. *Whorls* 9–10, pretty high, angulated, a little constricted and concave above the keel, and very slightly convex below it; the base is conical, very slightly concave and prolonged into a short, slightly reverted snout. *Suture* sharp, and slightly canaliculated in consequence of the squarish edge of the inferior whorl not quite reaching the first basal thread; between these two the suture lies in a minute square-cut depression. *Mouth* club-shaped, being oval above, with a short, somewhat oblique canal in front. *Outer lip* well arched, with an extremely slight shallow and open sinus. *Inner lip*—a very narrow glaze spreads across the slightly concave body, and down the pillar, which is short, rather narrow, and somewhat bent to the left in front; and here the inner edge is strong, sharp, a little twisted, and runs out to a sharp point at the end of the pillar. H. 0·66. B. 0·23. Penultimate whorl, height 0·12. Mouth, height 0·23, breadth 0·11.

The place of this shell is very doubtful; but there is a very slight upward and backward drawing of the lip below the suture; and this is further prolonged in a slight concavity, which may be reckoned as a sinus.

67. PLEUROTOMA (DRILLIA) AMBLIA, n. sp. (ἀμβλύς, blunt.)

St. 24. March 25. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Culebra Island, St. Thomas, Danish W. Indies. 390 fms. Coral-mud.

Shell.—High, narrow, conically cylindrical, with a blunt bulbous apex, a contracted base, and an elongated snout, bluntly angulated, ribbed, an impressed suture; porcellaneous. *Sculpture.* Longitudinals—the whorls are crossed from suture to suture by slightly curved, hardly oblique ribs, whose convexity is to the left; they do not extend to the base of the last whorl; they are narrow, rounded on the top, feeble above and below, and prominent in the middle; they are parted by unequal furrows broader than themselves; there are 17 on the last whorl, and they decrease up the spire, only 12 being found on the first and second regular whorls; the lines of growth, which agree with the ribs, are fine,

smooth, and unequal. Spirals—there are none but fine, regular, very faint microscopic scratches; though a few regular equidistant impressed lines cross the snout. *Colour* siliceous yellowish-white. *Spire* conically cylindrical, the body-whorl being narrow, and the highest whorls rather broad; the profile-lines are very much interrupted by the prominence of the keels and the contraction of the sutures. *Apex* consists of 1¼ swoln rounded smooth whorls, of which the extreme tip lies over on one side, but, though somewhat compressed, is still a little prominent, and is well defined by the impressed suture. *Whorls* 8½, of very slow increase, rather high, the last small; the projection on the longitudinal ribs forms a sharpish keel above the middle of the whorls; but the whorls themselves are not really carinated; the base contracts rather slowly, and runs out into a longish snout. *Suture* fine, superficial, well marked from the contraction in which it lies. *Mouth* club-shaped, small; but it and the pillar are a good deal broken in the only specimen. *Outer lip* very regularly convex to the canal-edge, where it becomes concave and then straight; it retreats on leaving the body; but the sinus is excessively shallow, open, and slight. *Inner* lip narrow; it is slightly concave on the body, and then straight on the singularly strong pillar. H. 0·45. B. 0·14. Penultimate whorl, height 0·06. Mouth, height 0·17, breadth 0·1.

For both height and breadth I have had here to make allowance, in consequence of the broken condition of the last whorl.

68. Pleurotoma (Drillia) aglaophanes, n. sp. (ἀγλαοφανής, bright.)

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Culebra Island, St. Thomas, Danish W. Indies. 390 fms. Coral-mud.

Shell.—High, narrow, conically cylindrical, with a blunt, flatly rounded apex, a short conical base, and scarcely any snout, hardly angulated, ribbed, contracted in the sinus-area, but barely so at the suture; grey, with a silvery sheen. *Sculpture.* Longitudinals—the whorls are crossed from suture to suture by low, sharpish, subangulately projecting, sinistrally convex, hardly oblique ribs, which run continuously, but slightly diminishing in number, up the spire, there being about 15 on the last and 11 on the first regular whorl; on the base they bend strongly to the left, and

die out at the point of the snout; they are parted by hollowed furrows which are rather broader than they; both ribs and furrows are scratched with very fine, almost microscopic lines of growth, which coincide with the course of the ribs; in the furrows a few of these lines are slightly stronger than the rest. Spirals—below the sinus-area is a very slight angular projection of the whorls, which is made more marked by a thickening and elevation of the ribs at this point; this is a feature which on the earlier whorls is very distinct, the whole rib being individualized by the central nodule into which it rises; but further on these nodules lose in importance. At the top of each whorl and close to the suture lies a small flattened thread, rising into minute longitudinal nodules at the ribs; below this and above the angulation is a slight furrow where the scars of the old sinuses occur. In all this part the surface of the shell is covered by minute spiral threads which lower down become stronger; they are parted by minute furrows of about the same breadth as the threads; these are all exquisitely fretted by the longitudinal scratches. *Colour* greyish, polished with a very beautiful silvery sheen on the whole surface. *Spire* conically cylindrical, the body-whorl being small and the apex broad in proportion to the size of the shell; the profile-lines are hardly interrupted by the sutures. *Apex* consists of $1\frac{1}{4}$ broad, depressed, and flatly rounded, smooth whorls. *Whorls* 8, of very slow increase, short, the last very small, being scarcely at all more tumid than the rest, and having a short conical base; the snout is very short; there is a small constriction round the top of each whorl; and the profile-lines are faintly angulated, but are very slightly convex. *Suture* fine, but well marked, being slightly impressed and defined by the slight swelling round the top of the inferior whorl; the superior whorl scarcely contracts towards it. *Mouth* pear-shaped, with a slight angulation at the top and a very short canal below. *Outer lip* evidently thickened, but chipped in the only specimen present; it runs with an almost continuous slightly convex curve from the body to the canal, where the curve is slightly and shortly flattened; the sinus is very shallow and open. *Inner lip* thickened and raised on a small but defined callus; it runs straight across the body to the base of the short, thick pillar, down which it proceeds direct and parallel to the slightly prominent callus-edge on the left; the point of the pillar is rounded and blunt,

and hardly advances to the end of the snout, the canal-edge being thick and rounded, cut off obliquely upwards, but not at all reverted. H. 0·3. B. 0·1. Penultimate whorl, height 0·03. Mouth, height 0·1, breadth 0·06.

This is an extremely peculiar little shell, remarkable in its narrow cylindrical and compact form, its sculpture, and its slight silvery sheen, from which last feature its name is derived.

69. PLEUROTOMA (DRILLIA) LOPHOËSSA, n. sp. (λοφόεις, crested.)

St. 120. Sept. 9, 1873. Lat. 8° 37′ S., long. 34° 28′ W. Pernambuco. 675 fms. Mud.

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Pernambuco. 350 fms. Mud. Var. PLATIA (πλατύς).

Shell.—High, narrow, conically cylindrical, with a blunt round apex, a contracted conical base, and shortish snout; it is angulated, and the angulation crested with little conical points; there are feeble ribs and an impressed suture. *Sculpture.* Longitudinals—there are 12–13 ribs on each whorl from the second regular whorl onwards; but they are in no way connected from whorl to whorl; they originate below the sinus-area in a little sharpish rounded nodule; crowning an angulation of the whorl at that point, they run forward direct but obliquely to the inferior suture; on the base they die out with a backward curve to the left, and do not reach the snout; in the sinus-area above the nodule they are just traceable in a slight irregularity of the surface and a minute nodule at the suture; the lines of growth are quite independent of the ribs, and are very faint except towards the point of the base. Spirals—at the top of each whorl is a minute projecting band beset by very small conical nodules corresponding to the longitudinal ribs. About one third down the whorls there is an angulation accentuated by the rib-nodules; halfway between this and the inferior suture a minute sharpish thread appears on the penultimate whorl, while other four, similar and equally parted, appear on the base; all these five threads rise on the ribs into minute sharpish nodules. On the snout there are neither ribs nor spiral threads, only obsolete lines of growth. *Colour* pale greyish-white. *Spire* conically cylindrical, the last whorl being very small and the earlier ones broad; the profile-lines are interrupted by the nodulous angulation and the im-

pressed suture. *Apex* consists of 1½ smooth, globularly rounded whorls, the extreme point of which has the slightest possible prominence. *Whorls* 7½–8, of very slow increase, short, the last scarcely more tumid than the rest, with a contracted conical base and a shortish snout; they are angularly convex, with a slight contraction into the suture both at the top and bottom of each whorl. *Suture*: there is a minute angular impression at the line of suture, which is marginated below and is made yet more distinct by the contraction of the whorls above and below. *Mouth* pear-shaped, small, with a slight angulation above and a rather wide and open canal below. *Outer lip* forms a regular curve, steeper above, and more drawn out below towards the point of the shell; on leaving the body it retreats, at once and very much, to the left; after forming a shallow, open, rounded sinus, it advances to the right and forward as a small low-shouldered pinion, retreating along the edge of the canal to the point of the shell. *Inner lip* narrow, slightly sunken, so that the surface of the shell slightly projects at the edge of it; its line across the body is straight, being neither convex nor concave. The pillar is narrow, strong, and very short, being obliquely cut off early, with an angularly rounded, slightly twisted edge and a backward truncated point. H. 0·3. B. 0·11. Penultimate whorl, height 0·05. Mouth, height 0·1, breadth 0·07.

This is another of that curious group which have a tendency to a cylindrical form, a long spire, many short whorls, a broad apex, and a short base.

I have with some hesitation united to this species as a var. PLATIA (πλατύς, broad) the specimens from St. 122. As the name indicates, they are broader in proportion to height; they are also less cylindrical, the embryonic whorls in particular, the tip being rather smaller and the basal part of the apex broader; the threads on the base of the shell are weaker. On the other hand, the whole form of the whorls and the details of sculpture are identical. In these circumstances it is probably wiser to unite them all in one species, attributing the differences partly to habitat and partly to the specimens of the variety being not fully grown.

70. PLEUROTOMA (CLIONELLA) QUADRUPLEX, n. sp.
St. 73. June 30, 1873. Lat. 30° 30′ N., long. 31° 14′ W.

W. of Azores. 1000 fms. *Globigerina*-ooze. Bottom-temperature 39°·4.

Shell.—Very high and narrow, conical, scalar, ribbed, bluntly keeled, with a very short conical base. *Sculpture.* Longitudinals—below the suture is a double collar of small close-set tubercles prolonged downward into folds; below these at the keel are swellings, whence descend flat, rounded, rather feeble ribs, which die out before they reach the lower suture; the surface is closely scored with unequal straight lines of growth. Spirals—there are very many strongish rounded threads parted by fine shallow rows of equal width; these are crowded on the shoulder. On the middle of the body-whorl a feebler thread appears, like a shadow in the furrows. *Colour*: it is bleached dead white. *Spire* very high and narrow, scalar. *Apex* broken. *Whorls*: only 5 remain; they are high and narrow, droopingly shouldered above, bluntly keeled, cylindrical, but contracting from the keel to the lower suture; the last is narrow, small, and cylindrical, but a very little swoln, with a short very one-sided conical base. *Suture* strong, irregular, a little constricted. *Mouth* narrowly oval, small, bluntly pointed above. *Outer lip* flatly arched. *Inner lip* slightly excavated, concave above, with a straight, shortish, and strong pillar. H. 1·9. B. 0·57. Penultimate whorl, height 0·38. Mouth, height 0·8, breadth 0·35.

This is a singularly attenuated form of great beauty, unhappily much broken. The generic sinus exists merely in the form of a very slight retreat of the lip from the suture to the keel. In classing it with *Clionella* I have followed the advice and example of Mr. E. A. Smith, while Adams regards that group as freshwater and allied to *Melania*. The name is derived from the very remarkable structure of the shell, which consists of 4 layers: the inmost of these is porcellaneous and very thin; the next is made up of spiral fibres; the third consists of longitudinal fibres (both of these being comparatively thick), while the outside is membranaceously cretaceous.

On the Freshwater Shells of Australia. By Edgar A. Smith. (Communicated by Dr. J. Murie, F.L.S.)

[Read April 21, 1881.]

(Plates V.-VII.)

Our knowledge with respect to the freshwater shells of the Australian continent is comparatively in its infancy. Although more than one hundred and fifty species are now known (many of these but unsatisfactorily), this, in comparison with the extent of the country, is but a small number, probably not a moiety of those existing; and there is but little doubt that, in the course of time, when the known rivers and lakes and those as yet unexplored have been thoroughly investigated, many new species will be discovered.

Judging from those with which we are now acquainted, no very strange forms are to be expected; for, with the exception of the elongate *Unio novæ hollandiæ*, with its tuberculose surface and black epidermis, there are scarcely any except very ordinary types among them. The existence of a species apparently belonging to the African genus *Physopsis* is certainly remarkable; and another shell, described as a *Mycetopus*, if truly belonging to that genus, is interesting as the representative of a South-American group. However, it is not at all improbable that, whenever the animals inhabiting these two shells are examined, they will prove very different from those belonging to the genera to which they have been referred.

A few of the species hereafter enumerated are not peculiar to Australia; and among them may be instanced the ubiquitous *Melania tuberculata*, *M. amarula*, *Neritina crepidularia*, and *N. pulligera*. The most numerously-represented genus is *Physa*. Of this group no less than 52 distinct forms have been described. Some of these may eventually prove to be mere varieties, possessing no essential constant specific characters; but others new to science will in all probability ere long be added to the list. *Unio* is the next most important group in point of numbers, being represented by 17 different species. Then follows *Melania* with 12, *Neritina* with 10, *Limnæa* with 11, *Paludina* and *Corbicula* each having 9 species, *Hydrobia*? 6, *Planorbis* 6, *Sphærium* and *Bithynia* 4, *Pisidium* 3, *Segmentina* 2; and, finally, *Tatea*, *Amnicola*?, *Paludinella*?, *Larina*, *Gabbia*,

Ancylus, *Physopsis*, *Mycetopus*, and *Navicella* have but single representatives.

The great uncertainty and difficulty in determining the limits of most freshwater shells is well known. On this account, and considering the insufficient amount of material to work with, I trust that great allowance will be made for those errors which undoubtedly exist in the following account. However, I am confident that my labour has not altogether been expended in vain; for to bring together a list of the known species and to correct and amplify some of the descriptions will, it is hoped, be of some use to those who may hereafter study this particular group, and have not access to the types preserved in the British Museum.

In conclusion, I have to thank, on behalf of that institution, Mr. John Brazier of Sydney, who some time ago presented a large series of shells from the Australian rivers, especially valuable, as to each specimen its particular locality is attached.

To Mr. Taylor, editor of the 'Journal of Conchology,' my thanks are also due for the loan of another set, including three species of *Physa*, described in that publication by himself and Mr. Nelson.

I should also state that I have not included in this account the freshwater shells of Tasmania, as this subject has been investigated by more competent naturalists resident in that island. Mr. Tenison-Woods, Mr. Johnston, Mr. Brazier, Mr. Petterd, and others have written many valuable contributions to the knowledge of that subject. Considering the ease with which the ova of most species can be carried from place to place, it is very probable that some of the Tasmanian species will hereafter be proved to be the same as others from the mainland; and this is a subject to which I call the attention of Australian conchologists.

Genus Melania.

1. Melania amarula, *Linn.*

Hab. Amboina (*Rumph*): Sumatra, Fiji Islands, Solomon Islands, Mauritius, Madagascar, Nicobar Islands, &c. (*Brit. Mus.*): Saltwater Creek, Cardwell, Rockingham Bay, Queensland (*Brazier* and *Beddome*).

Mr. Beddome remarks that the creek is always freshwater where these are found.

The specimens from Australia have the form of the variety

known as *M. cybele* of Gould, and the whorls are crowned with numerous acute denticles. They are coated with a black earthy deposit, but exhibit sufficient traces of the epidermis to show that it has been of the same villose character peculiar to this species. The columella is stained reddish, and the aperture is a little paler.

The *M. amarula* of the twelfth edition of the 'Systema Naturæ' was founded upon Rumph's description and figure, the latter being apparently roughly copied by Argenville. Rumph's specimens were from Amboina, by the natives of which island they are called Laholun, Lahorun, and Papeÿte, which signifies bitterish (*amarula*), the name adopted by Linné. If his figure be correct, the shell delineated was of rather short proportions, had the short spines at the top of the whorls well developed, and about twelve on a whorl.

The specimen in the Museum which most nearly resembles the figure is Sumatran, and approximates much more closely to it than that figured by Reeve from the Mauritius. His figure (175 *a*), representing the dorsal view of what he calls *Melania mitra*, is much more like Rumph's figure than his fig. 177.

In the 'Conchylien-Cabinet' Brot gives seven figures in illustration of this species, of which fig. 1 *d* appears to me to represent very closely the general proportions of Rumph's specimens.

As far as my present knowledge of these forms extends, I am unable to distinguish any *constant* differences in several so-called species, such as *M. mitra* (Meuschen), Reeve, *M. villosa*, Philippi, *M. cybele*, Gould, *M. crenularis*, Deshayes, *M. thiarella*, Lamarck, *M. cornuta* and *M. diadema*, Lea; the two latter, however, may differ somewhat in the character of the epidermis.

2. Melania balonnensis, *Conrad.* (Plate V. figs. 1–3.)

Melania balonnensis, *Conrad, Proc. Acad. Nat. Sci. Philadelphia*, 1850, vol. v. p. 11; *id. American Journ. Conch.* vol. ii. p. 80, pl. i. fig. 10; *Brot, Küster's Con.-Cab.* p. 287, pl. xxviii. figs. 14–14 *b* & 15.

Melania tetrica, *Conrad, P. A. N. S. Phil.* 1850, vol. v. p. 11; *id. Am. Journ. Conch.* vol. ii. p. 80, pl. i. fig. 9; *Brot, Am. Journ. Conch.* vol. vi. *Append.* p. 303.

Melania incerta, *Brot, Matériaux*, i. p. 52; *id. Am. Journ. Conch.* vol. vi. *Append.* p. 303.

Melania lirata, *Menke* (*non Benson*), *Moll. Nov. Holl.* p. 9.

Hab. Balonne River and rivers of S.E. Australia (*Conrad*): Port Curtis, Queensland; Upper Clarence River and Paterson

River, New South Wales, and Murray River (*Brazier*): North Australia (*J. R. Elsey*): Mackenzie River (*Port-Essington Expedition* 1845): Burdekin River, Queensland (*Brazier* and *Port-Essington Expedition* 1845): Victoria; S. Australia (*Brit. Mus.*).

Dr. Brot appears to me quite correct in uniting *M. tetrica*, Conrad, with this species. The colour, as well as the sculpture, is subject to considerable variation. Some specimens are uniformly olivaceous, whilst others are closely spotted with small streaks and minute dots of a dark red, the latter being pretty constantly upon the spiral raised ridges. Two or three of the latter, around the middle of the whorls of the spire and at the upper part of the last volution, become more or less tubercular on crossing the plicæ.

Some of the specimens from the Burdekin River are remarkable for their large size and their general resemblance to *M. scabra* of Müller. The largest is 34 millim. long and 12 wide. The costæ are more numerous and less prominent than in the normal form, the tuberculation in consequence being likewise more feebly expressed, and the last volution is large and ventricose. To give an idea of the great variation in the number of longitudinal plicæ, I may note that the specimen bearing the fewest has but seven on the last whorl, whilst one (from Limestone Creek, Burdekin River) has just double that number. *M. scabrella* of Philippi, said to come from Java, is very like this species, and may eventually prove to be the same.

3. MELANIA AUSTRALIS, *Lea*.

Melania australis, *Lea, Proc. Zool. Soc.* 1850, p. 185; *Brot in Küster's Con.-Cab.* p. 285, pl. xxviii. fig. 17 (copied from Reeve) & 17 *a*, pl. xxxi. fig. 3; *id. Amer. Journ. Conch.* vi. *Append.* p. 303.

Melania australis, *Reeve, Con. Icon.* fig. 82; *Smith, Voy. Erebus & Terror*, pl. iv. fig. 3.

Melania decussata, *Brot, Matériaux*, i. p. 55.

Melania cerea, *Brot, Rev. Zool.* 1860, pl. xvii. fig. 13; *id. Con.-Cab.* pl. xxviii. fig. 16; *id. Amer. Journ. Conch.* vi. *Append.* p. 303.

Hab. Victoria River, N. Australia (*Lea* and *Reeve*): Fitzroy River, Swan River, Port Essington, and River-head, Dampier's Archipelago (*British Museum*).

The most common form of this species is that figured by Brot under the name of *M. cerea*. The ribs on the body-whorl are not usually so much developed as they appear to be in the specimen figured in the 'Conchologia Iconica.' In this respect it

rather agrees with Lea's description of them, "plicis numerosis, crebris," than with Reeve's, "plicis varicosis, distantibus."

There are several specimens in the Museum, received from Mr. J. R. Elsey from N. Australia, which differ from the normal form in having the last whorl less ventricose, streaked and spotted with reddish brown, and the whorls of the spire a little angulated at the upper part. These differences, however, are scarcely sufficient to distinguish them specifically.

4. MELANIA CARBONATA, *Reeve.*

Melania carbonata, *Reeve, Con. Icon.* fig. 88; *Brot, Con.-Cab.* p. 153, pl. xix. fig. 3.

Hab. Port Essington (*J. B. Jukes* and *Gould*).

The mouth of this species is usually not quite so broad as Reeve's figure represents it, and the colour rather browner.

5. MELANIA TUBERCULATA, *Müller.*

Hab. Upper Brisbane River, Queensland (*Brazier*).

I am not aware that this very widely-distributed species has been before recorded from Australia.

6. MELANIA ONCA, *A. Adams & Angas.*

Melania (Melasma) onca, *A. Ad. & Ang. Proc. Zool. Soc.* 1863, p. 415; *Brot, Con.-Cab.* ed. 2, p. 330, pl. xxxiv. fig. 7.

Hab. Adelaide River, N. Australia.

7. MELANIA DENISONIENSIS, *Brot.* (Plate V. figs. 4–8.)

Melania denisoniensis, *Brot, Con.-Cab.* p. 234, pl. xxv. fig. 6 *a–b.*

Hab. Port Denison, Queensland (*Brot*); Burdekin River, Cardwell and Rockhampton (*Brazier*).

The series of this species sent to the Museum by Mr. Brazier exhibits very considerable variation. The specimens, with one exception, described by Brot, on the other hand, were very similar, exhibiting only a difference in the prominence of the keel or angulation on the last whorl, and in the amount of the transverse striation. The largest shell in the series before me is very minutely spirally striated, with rather high whorls, and the aperture longer than usual. It would, if complete, have been about 60 millim. in length and 16 in diameter. It is of a very dark, almost black, colour, and traces of spots beneath the thick epidermis can be detected below the suture of some of the upper

whorls. It has no angulation whatever on the body-whorl. On the other hand, another example, equally large, and of the same dark tint, is very strongly carinate about two millim. from the suture, thus producing a conspicuous oblique tabulation. This, however, only extends as far as the penultimate volution, the rest of the whorls being merely slightly convex.

A fairly constant character, judging from the series before me, appears to be in the upper whorls of the spire being spirally striated throughout, whilst those lower down are more or less devoid of striæ at the upper part. The colour of the aperture also differs, sometimes being of a dirty pale bluish, and at others brownish. The basal brown band, too, is scarcely observable in large specimens, whereas in younger shells it is usually quite conspicuous; but even in some of these it is absent.

8. MELANIA ONCOIDES, *Tenison-Woods.*

Melania oncoides, *Tenison-Woods, Proc. Linn. Soc. N. S. Wales,* vol. iii. 1878, p. 5.

Hab. In creeks near Bourke, Darling River (*Tenison-Woods*).

The author describes this species as very close in form and colouring to *M. onca*, Angas. It is, however, smaller, conspicuously lirate, and scarcely plicated, except upon the upper whorls. The colour, too, is described as very pale yellow, marked longitudinally with red undulating lines. On the contrary, *M. onca* is clothed with a pale olive epidermis, and the dark-red markings consist of dots forming transverse longitudinal series.

9. MELANIA VENUSTULA, *Brot.* (Plate V. figs. 9–10.)

Melania venustula, *Brot, Con.-Cab.* ed. 2, p. 331, pl. xxxiv. figs. 5–5 *a*.

Hab. Port Denison (*Brot*); Victoria River, N. Australia (*J. R. Elsey*); Cape Upstart (*Brazier*).

One specimen from North Australia, presented to the Museum by J. R. Elsey, Esq. (*vide* fig. 10), is of a much more elongated form than that described by Brot, or either of the two specimens received from Mr. Brazier. It is acuminate, greenish yellow, without spots, obliquely longitudinally closely ribbed, and transversely sulcated upon the lower half of the body-whorl; spire acute. Whorls about 10, nearly flat, or scarcely convex; body-whorl rounded at the middle, at which point the costæ abruptly terminate and the spiral sulci commence. Aperture rather livid within, occupying a little less than one third of the entire length of the specimen.

Lip broadly sinuated at the upper part and prominent below. Columella covered with a whitish callus. Length 31 millim., diam. 9, aperture 9 long and $4\frac{1}{4}$ broad.

10. Melania queenslandica, n. sp. (Plate V. fig. 11.)

Shell ovately subfusiform, thick, decollated, greenish olive, smooth; sculptured with lines of growth, and a few revolving striæ at the base of the body-whorl. Volutions ? 10; four or five remaining ones flat at the sides, divided by a deepish and slightly oblique suture. Spire apparently rather sharply conical. Last whorl long, flattish at the upper part, very little rounded at the middle and below. Aperture bluish, elongately subpyriform, occupying about three eighths of the probable length of the shell. Lip thin; viewed laterally, it appears broadly sinuated at the upper part, and very much produced at and below the middle. Columella thickened with a white callus below the middle where it joins the base, only a little arcuate. Parietal callosity thin, bluish.

Probable total length 40 millim., actual length of four whorls 33, diam. 12, aperture $14\frac{1}{2}$ long and 6 wide.

Hab. Saltwater Creek, Cardwell, Queensland, near the coast; and Paroo River, Queensland (*Brazier*).

This is very distinct from any other of the Australian species. The smooth surface, the greenish-olive colour, the decollated spire, and especially the long body-whorl are the principal characteristics.

11. Melania Elseyi, n. sp. (Plate V. fig. 12.)

Shell elongate, acuminate, olivaceous (probably), spotted and streaked with reddish brown. Whorls 10, somewhat convex, furnished with slightly oblique and arcuate plicæ (about 12 on the penultimate whorl), crossed by a few spiral striæ, which are most conspicuous near the suture, both above and below. Plicæ upon the last volution obsolete about the middle, the transverse striæ extending to the base. Aperture ovate, acute above. Columella coated with a callosity.

Length 31 millim., width $10\frac{1}{2}$.

Hab. Australia (*J. R. Elsey*).

This species is more elongated than *M. australis*, with finer spiral striation and differently coloured. Unfortunately the only specimens in the Museum are in a dead condition and have lost the epidermis. This probably was of an olivaceous tint. The

shells in their present state are white, with reddish-brown streaks between the plicæ; these being more or less interrupted at the middle, form two series of oblong spots, one at the upper part of the whorls and one beneath. Upon the last volution the lower series are prolonged into wavy streaks extending to the base. The striæ are coarser upon the upper whorls than upon the last three or four, and, cutting across the plicæ, give the latter a nodulous appearance.

12. Melania subsimilis, n. sp. (Plate V. fig. 13.)

Shell elongate, turreted, yellow, streaked and dotted with red. Whorls about 10, shallowly excavated at the upper part, and slightly convex beneath the depression, obliquely plicated and spirally grooved. Plicæ about 12 in number upon a whorl, frequently almost obsolete upon the last, most conspicuous near the middle, and scarcely attaining to the suture either above or below; upon the upper whorls they are decidedly granose, through being cut across by the spiral grooves. Upon the last and penultimate volutions the nodules are one or two in number upon the plicæ; but further up the spire they are three or four; the uppermost ones mark the extent of the shallow depression, and stand out a paler colour than the rest of the surface. Last whorl grooved and ridged throughout. Ridges about 14 in number, those near the middle rather the coarsest. Aperture ovate, about one third the length of the shell, exhibiting the spotting of the exterior. Columella arcuate.

Length 25 millim., diam. 8.

Hab. Australia (*J. Gould.*)

M. balonnensis is the nearest ally of the present species. The latter is more elongated and narrower, has a less decided angulation near the middle of the whorls, and a general smoother appearance owing to the transverse grooves being shallower. The painting of the two species is very similar; but the epidermis of that described by Conrad, judging from the series in the Museum, is not so yellow as that which clothes the eight specimens of *M. subsimilis.*

Genus Vivipara.

Two peculiarities are constant in all the Australian species of this genus. Every example that has come under my examination exhibits spiral sculpture; and in none of them are colour-bands

found below the periphery. Mr. Brazier, however, has described one, *V. Alisoni*, as "smooth." I shall be glad to know whether in reality minute spiral sculpture is altogether absent in that species.

13. VIVIPARA SUBLINEATA, *Conrad.*

Paludina sublineata, *Conrad, Proc. Acad. Nat. Sci. Philad.* 1850, p. 11.

Vivipara sublineata, *Conrad, Am. Journ. Conch.* vol. ii. p. 79, pl. i. fig. 8.

Paludina polita, *Martens, Ann. & Mag. Nat. Hist.* 1865, vol. xvi. p. 256 (*non* Viv. polita, *Frauenfeld, Verhandl. zool.-botan. Ver. Wien*, 1862, p. 1163).

Hab. Darling River (*Conrad*); Balonne River (*M'Gillivray*); Lake Alexandria (*Strange*); Bogie River, Queensland (*Brazier*).

The subcarination near the periphery of the body-whorl mentioned by Conrad is also present in some of the specimens described by Martens.

14. VIVIPARA ESSINGTONENSIS, *Shuttleworth.*

Vivipara essingtonensis, *Frauenfeld, Verhandl. zool.-botan. Vereins Wien*, 1862, p. 1162.

Vivipara suprafasciata, *Tryon, Amer. Journ. Conch.* vol. ii. 1866, p. 8, pl. ii. fig. 7.

Hab. Port Essington (*Frauenfeld*); tropical Australia (*Tryon* and *M'Gillivray*); Victoria River, North Australia (*J. R. Elsey*); Cleveland Bay, Queensland (*Brazier*).

There appears to me no difference between the *V. suprafasciata* of Tryon and this species, except that the former, judging by the figure, seems rather broad. Possibly this may be an exaggeration and incorrectly drawn; for it is certainly broader than the dimensions given in the text.

Three specimens from Cleveland Bay, presented to the Museum by Mr. Brazier, are remarkable on account of their bright olive-green colour and the blackness of the transverse lines. Of these, the three principal ones on the body-whorl occupy the positions always observable in this species—namely, the lowermost being at the periphery and terminating in front just above the aperture, the uppermost one distant 2 to 3 millim. from the suture, and the intermediate one more or less equidistant between the others. Besides these, there are at times finer interjacent lines, which, however, are more frequently above the uppermost, or between that and the next beneath than between the latter and the lowermost principal bands. The peristome in these three examples is unusually stained with black.

15. VIVIPARA AMPULLAROIDES, *Hanley*.

Vivipara ampullaroides, *Hanley, Con. Icon.* (Paludina), fig. 30.

Paludina australis, *Reeve, Con. Icon.* fig. 71; *Martens, Ann. & Mag. Nat. Hist.* 1865, xvi. p. 255; *Smith, Voy. Erebus & Terror*, p. 3, pl. iv. fig. 19.

Paludina affinis, *Martens, l. c.* p. 256.

Hab. —— ? and Victoria River, N. Australia (*Reeve*); Fitzroy River and Port Essington (*Capt. Wickham*).

It is difficult satisfactorily to draw a line of separation between this species and *V. essingtonensis*. It has rather less of an umbilicus and less convex whorls. The aperture, too, is a little acuminate at the base at a point where an obtuse angulation around the umbilical region terminates on the peritreme. The latter is somewhat, as it were, pressed down on the columellar side, reflexed and bordered with dark olive. The typical specimens of *V. ampullaroides*, *V. australis*, and *V. affinis* are all in the Museum collection, so that I can state with certainty that they are identical. Reeves describes the sculpture of *V. ampullaroides* as "minutely punctured," and that of *V. australis* as "minutely striated." On examining the shells figured, their sculpture proves to be of precisely the same character.

16. VIVIPARA WATERHOUSII, *A. Adams & Angas*. (Plate VII. fig. 14.)

Vivipara Waterhousii, *A. Adams & Angas, Proc. Zool. Soc.* 1863, p. 414.

Hab. Newcastle waters, Arnheim's Land, N. Australia.

17. VIVIPARA KINGI, *A. Adams & Angas*. (Plate VII. fig. 15.)

Vivipara Kingi, *A. Adams & Angas, Proc. Zool. Soc.* 1863, p. 415.

Hab. King's Ponds, Arnheim's Land.

This species resembles to some extent *V. intermedia*; but is distinguished by its larger umbilicus and the paler colour of the aperture.

18. VIVIPARA INTERMEDIA, *Hanley*.

Vivipara intermedia, *Hanley, Conchol. Icon.* (Paludina), fig. 57 (1863).

Paludina purpurea, *Martens, Ann. & Mag. Nat. Hist.* 1865, xvi. p. 428; *id. Mal. Blat.* 1865, p. 150.

Hab. —— ? (*Reeve*); Murray River, Australia (*Martens*).

The specimens described by Martens were received from Mr. Krefft. The British Museum is also indebted to the same gentleman for three examples from the same river with the follow-

ing remark :—" Under water and old dead logs, and embedded in mud." On comparing these with the type of *V. intermedia*, I cannot trace any specific distinction.

19. VIVIPARA ALISONI, *Brazier*.

Vivipara Alisoni, *Brazier*, *Proc. Linn. Soc. N. S. Wales*, 1879, vol. iii. p. 221.

Hab. Dalmatia River, Queensland.

From the brief description of this species, it appears to differ from *V. sublineata* in the whorls being only "slightly convex" and "smooth." The latter character, if it apply to the absence of spiral striation, at once distinguishes this species from all the other known forms inhabiting Australia.

20. VIVIPARA TRICINCTA, n. sp. (Plate VII. fig. 16.)

Shell globosely conical, narrowly rimate, moderately solid, greenish yellow, encircled with three slightly raised, dark brown, subequidistant thickish lines, sculptured by the lines of growth and minute spiral lirulæ visible only under a lens, most conspicuous upon the spire and unequal in strength. Whorls 5, moderately convex, the penultimate somewhat bicarinated by the two raised brown lines, which are considerably paler, yet more prominent than upon the last volution; upon this the uppermost and lowermost lines are more raised than the intermediate one. Aperture ovately circular, bluish white, the exterior bands being visible only far within, occupying rather more than half the entire length of the shell. Peristome simple, thin; columellar margin narrowly reflexed and depressed, united to the termination of the outer lip by a thin bluish-white callus.

Length 22 millim., greatest diameter 18, above aperture 14; aperture 12 long, 10 broad.

Hab. North Australia (*J. R. Elsey*).

This species, of which there are eleven specimens in the Museum, has the bands in the same position as the three chief ones in *V. essingtonensis*. In the latter, however, they are not raised. The whorls are less convex, the umbilicus much smaller, and the substance stouter. The prominence of the lines upon the penultimate volution, amounting almost to keels, is very peculiar. The apex also is not purplish to the extent it is in *V. essingtonensis*.

21. VIVIPARA DIMIDIATA, n. sp. (Plate VII. fig. 17.)

Shell ovately conical, thinnish, umbilicated, olivaceous above

the periphery, greenish beneath it. Spire livid, purplish. Whorls 5, moderately convex, minutely spirally striated. Striæ raised, subgranular through being crossed by fine lines of growth. Last volution not particularly swollen, exhibiting in some specimens a faint obtuse angulation at the middle. Aperture irregularly broadly ovate, somewhat acute above, and a trifle effuse or pointed at the base, occupying about five ninths of the whole length; the lower half of it is whitish, with a red stain at the base near the columella and at some distance from the basal margin of the peristome; the upper half corresponding with the exterior is darker in colour. Peristome but very little reflexed on the columellar side. Callus uniting the upper extremity and the columella very thin.

Length 19 millim., diam. above aperture 12; mouth 10 long, $7\frac{1}{2}$ wide.

Hab. Victoria River, N. Australia (*J. R. Elsey*).

This species may be known from *V. sublineata* by its rather narrower form, more conical spire, difference of colour, little wider umbilicus, narrower aperture and the red stain within it. The division of colour on the upper and lower part of the last whorl is more marked in some specimens than in others. The upper or dark colour in some examples exhibits faint indications of obscure narrow bands. The operculum is reddish, darker at the nucleus.

Genus Larina.

22. Larina Strangei, *A. Adams*.

Larina Strangei, *A. Adams, Proc. Zool. Soc.* 1854, p. 41, pl. xxvii. fig. 3.

Hab. Moreton Bay (*Adams*); Mackenzie River (*Brit. Mus.*).

This genus was supposed by Adams to be marine. It has, however, very close relationship with *Vivipara* on account of the similarity of the opercula; and it is undoubtedly a freshwater form, as is clearly proved by the Museum specimen, obtained in the Mackenzie River by the Port-Essington Expedition during the year 1845.

Genus Bithinia.

23. Bithinia vertiginosa, *Frauenfeld*.

Bithinia vertiginosa, *Frauenfeld, Verhandl. zool.-bot. Vereins Wien*, 1862, p. 1152, 1864, p. 665, 1865, p. 527, pl. ix.

Hab. New Holland (*Frfld.*).

24. BITHINIA SCHRADERI, *Frauenfeld.*

Bithinia Schraderi, *Frauenfeld, l. c.* 1862, p. 1153, 1864, p. 665, 1865, p. 527, pl. viii.

Hab. Australia? (*Frfld.*).

25. BITHINIA HYALINA, *Brazier.*

Bithinia hyalina, *Brazier, Proc. Linn. Soc. N. S. Wales,* 1875, vol. i. p. 9.

"Shell turbinated, thin, glossy, shining, whitish under a brown epidermis. Whorls 5, roundly convex; the last large, equalling half the length of the whole shell. Aperture somewhat lunate; peristome thickish; margins continuous. Length 4 lines, breadth $2\frac{1}{2}$.

"*Hab.* Eastern Creek, N. S. Wales.

"Found in various parts of New South Wales, about Parramatta and Chatsworth."—*Brazier.*

26. BITHINIA AUSTRALIS, n. sp. (Plate VII. fig. 18.)

Shell small, white, not perforate. Whorls 4–5, very convex, very finely striated by the lines of growth. Suture deep, scarcely oblique. Aperture small, obliquely oval, somewhat acute above, occupying less than half the entire length. Peristome continuous, a little prominent on the columellar side, thus producing a false umbilical rimation and somewhat thickened, thin elsewhere. Operculum normal, shelly.

Length 5 millim., diam. 3; aperture $2\frac{1}{3}$ long, $1\frac{1}{2}$ wide.

Hab. Victoria River, N. Australia.

Besides the striæ or lines of growth, by the aid of a compound microscope very fine transverse lines are observable.

Under the name of *B. affinis*, Brazier, two specimens found at Hillgrove Limestone Creek, Burdekin River, Queensland, have come under my observation, sent to Mr. J. Taylor of Leeds by Mr. C. E. Beddome of Hobart Town, Tasmania. They differ from those here described in having the last whorl smaller, the increase of the volutions appears to be less rapid, and the operculum is much more distinctly concentrically ringed by the lines of growth.

Genus GABBIA.

27. GABBIA AUSTRALIS, *Tryon.*

Gabbia australis, *Tryon, American Journal of Conchol.* vol. i. p. 220, pl. xxii. fig. 7.

Hab. New South Wales.

"The operculum is somewhat calcareous, like *Bithinia tentaculata*" (*Tryon*).

This genus requires further investigation in order to demonstrate its distinctness from *Bithinia*.

Genus PALUDINELLA ?

28. PALUDINELLA GILESI, *Angas*.

Paludinella Gilesi, *Angas, Proc. Zool. Soc.* 1877, p. 170, pl. xxvi. fig. 2.

Hab. Lake Eyre, South Australia.

The operculum of this species is described by Angas as "horny, paucispiral, with the nucleus subcentral." I have examined the only operculum accompanying four specimens, among them being the type, liberally presented to the British Museum by Mr. G. F. Angas; and it proves to be more of a concentric character, as in the genus *Vivipara*, with the exception of the subcentral nucleus, which exhibits about two spiral turns.

Genus AMNICOLA ?

29. AMNICOLA GRANUM, *Menke*.

Paludina granum, *Menke, Moll. Nov. Holl.* p. 8; *Philippi, Abbild.* i. p. 6, pl. i. fig. 16; *Küster, Con.-Cab.* p. 64, pl. xi. figs. 37–38.

Amnicola granum, *Frauenfeld, Verhandl. zool.-botan. Vereins Wien*, 1864, pp. 611 & 663.

Hab. Among white quartz-sand on the banks of the Swan River (*Menke*).

The generic position of this little shell is at present doubtful, and it is unknown whether it is a marine or fluviatile form.

Genus TATEA.

30. TATEA RUFILABRIS, *A. Adams*. (Plate VII. fig. 19.)

Diala rufilabris, *A. Ad. Ann. & Mag. Nat. Hist.* 1862, p. 298.

Hydrobia rufilabris, *Smith, Proc. Zool. Soc.* 1875, p. 538.

Bythinia huonensis, *Tenison-Woods, Proc. Roy. Soc. Tasm.* 1875, p. 71; *id. Trans. Roy. Soc. Victoria*, 1878, vol. xiv. p. 62; *Petterd, Journ. Conch.* vol. ii. p. 93 (Bithynia).

Tatea huonensis, *Tenison-Woods, op. cit.* 1878, p. 72.

Hab. Port Lincoln (*Adams*); South Grafton, Clarence River, New South Wales (*Brazier*); Huon River, Tasmania (*Tenison-Woods & Beddome*); Melbourne, Victoria (*Petterd*; also *Tenison-Woods*).

Adams's description was founded on old worn specimens, void of the dark brown epidermis which everywhere covers the surface. The operculum is said to be "calcareous, with a vertical submarginal claw" (*Tenison-Woods, l. c.* p. 71). As far as I can discover, judging from an external view, it appears to be thin, horny, paucispiral, with the nucleus subcentral, but rather towards the base or lower end.

Lieut. C. E. Beddome, I.N., kindly presented to the British Museum some examples of *Tatea huonensis*, which, on comparison, prove to be identical with the *Diala rufilabris* of A. Adams.

Genus Hydrobia.

31. Hydrobia* buccinoides, *Quoy & Gaimard.*

Paludina buccinoides, *Quoy & Gaim. Voy. Astrolabe*, vol. iii. p. 175, *Atlas* pl. lviii. figs. 13–15.

Hydrobia buccinoides, *Frauenfeld, Verhandl. zool.-botan. Vereins Wien*, 1864, pp. 582 & 665.

Hab. "Les marais saumâtres du port Weston," New Holland.

32. Hydrobia Preissii, *Philippi.*

Paludina Preissii, *Ph. Abbild.* ii. p. 137, pl. ii. fig. 12.

Hydrobia Preissii, *Frauenfeld, op. cit. suprà* pp. 637 & 667.

Hab. West Australia.

33. Hydrobia Brazieri, n. sp. (Plate VII. fig. 21.)

Shell trochoidal, subrimate, small, brown, coated generally with an earthy deposit, acutely keeled at the periphery. Whorls 5, moderately convex, striated by the lines of growth. Keel on body-whorl prominent, acute, falling just above the suture, and visible upon the upper whorls, obsolete on approaching the aperture. Base a little convex. Aperture broadly ovate. Peritreme continuous, a little thickened on the columellar side, and feebly expanded on the labral margin.

Length 3 millim., diam. 2; aperture $1\frac{1}{2}$ long, $1\frac{1}{4}$ wide.

Hab. South Grafton, Clarence River, New South Wales, in a freshwater creek (*Brazier*).

This species is well characterized by the sharp prominent keel which encircles the middle of the last volution. It does not, however, extend quite to the aperture, which consequently is not

* The generic position of this and the following nine species will remain in doubt until the animals have been carefully studied.

angular on the right or labral side. Its operculum is horny, brown, and littorinoid in character, consisting of about two and a half whorls.

I have much pleasure in associating this interesting form with the name of Mr. Brazier, who has sent a large series of it to the Museum.

34. Hydrobia victoriæ, *Tenison-Woods*. (Plate VII. fig. 20.)

Bythinia victoriæ, *Tenison-Woods, Trans. Roy. Soc. Victoria*, 1878, vol. xiv. p. 65.

Bythinella victoriæ, *Tenison-Woods, Proc. Roy. Soc. Tasmania*, 1878, p. 71.

Shell small, ovately conical, narrowly rimate, horn-colour, longitudinally striated, covered with a blackish earthy deposit. Whorls 5, smooth, very convex, separated by a deep suture. Apex rather obtuse. Aperture small, obliquely ovate, a trifle narrower above than below, but not acuminate, occupying about two fifths of the whole length of the shell. Peristome continuous and free from the whorl. Operculum horny, paucispiral.

Length 3 millim., diam. $1\frac{1}{2}$; aperture $1\frac{1}{4}$ long, $\frac{3}{4}$ wide.

Hab. St. Kitts, South Australia (*Angas*); Lake Connewarre, Geelong (*Tenison-Woods*).

I do not feel quite certain that the operculum is not slightly shelly; if so, the calcareous deposit is very thin indeed. Several specimens have been presented to the Museum by Mr. G. F. Angas. I am not absolutely certain that the specimens, the description of which is given above, are, without doubt, the *Bythinia victoriæ* of Woods. However, the diagnoses agree in many respects; and I prefer to leave the question to be decided by comparison of specimens to giving a new and possibly unnecessary name.

35. Hydrobia Petterdi, n. sp. (Plate VII. fig. 23.)

Shell very small, pale horn-colour, rimate, subpupiform, semitransparent, rather glossy, smooth. Whorls 4–5, very convex, and divided by a very deep suture; body-whorl only a trifle broader than the preceding. Aperture small, ovately circular, a little oblique, occupying about two sevenths of the entire length. Peristome continuous, free from the whorl. Operculum horny, thin, paucispiral.

Length 2 millim., diam. $1\frac{1}{4}$.

Hab. Richmond River, New South Wales, and Alert River, Queensland (*W. F. Petterd*).

36. HYDROBIA ANGASI, n. sp. (Plate VII. fig. 22.)

Shell ovately conical, narrowly rimate, smooth, yellowish olive, shining, covered with a blackish earthy deposit. Whorls 5, convex. Aperture ovate, oblique. Peristome continuous, free from the last whorl, the right margin being very slightly expanded.

Length $3\frac{1}{3}$ millim., diam. $1\frac{3}{4}$; aperture $1\frac{1}{2}$ long, 1 broad.

Operculum with a subcentral nucleus, paucispiral, horny, with a callosity on the inner surface, from the centre of which arises an apophysis which is directed towards the inner or columellar edge.

Hab. Compasely River, Victoria.

The operculum differs from that in *Eatoniella kerguelenensis* in having the nucleus more central; and notwithstanding its differing from the normal or typical form of the operculum in *Hydrobia*, at present I deem it advisable not to separate the species generically on that account alone.

Genus LIMNÆA.

37. LIMNÆA (AMPHIPEPLEA ?) LESSONI, *Deshayes*.

Limnea Lessoni, *Deshayes, Magasin de Zool.* 1830, p. 16, figs. 1–2; *Lesson, Voy. Coquille, Zool.* pl. xv. fig. 1; *id. Centurie Zoologique*, pl. xliv.; *Küster, Con.-Cab.* pl. v. figs. 16–17.

Lymnæa Lessonii, *Desh., Lesson, Centurie Zoologique*, 1830, p. 120, pl. xliv. (shell and animal).

Neristoma Lessoni, *Desh., Chenu, Man. de Conch.* vol. i. fig. 3542.

Lymnea perlevis, *Conrad, Proc. Acad. Nat. Sci. Philad.* 1850, vol. v. p. 11.

Amphipeplea perlevis, *Conrad, American Journ. Conch.* vol. ii. p. 80, pl. i. fig. 5.

Amphipeplea Strangei, *Pfeiffer, Malak. Blätt.* 1854, p. 64; *Novitat. Conch.* 1854, p. 6, pl. ii. figs. 5 & 6; *Küster, Con.-Cab.* p. 60; *Sowerby, Con. Icon.* fig. 40 (Limnæa).

Amphipeplea melbournensis, *Pfr.**, *Novitat. Conch.* p. 70, pl. xix. figs. 14–15; *Sowerby, Con. Icon.* fig. 38 *a–b* (Limnæa).

Limnæa globosa, *Sowerby, Con. Icon.* fig. 84.

Hab. New Holland (*Deshayes*); Macquarie River (*Lesson*); Salamanca and Balonne Rivers, New South Wales (*Conrad*); Moreton Bay, Queensland (*Pfeiffer*); Melbourne, Victoria (*Pfr.*);

* Pfeiffer, in the 'Novitates,' *l. c.*, gives a reference to Proc. Zool. Soc. 1856; but I have carefully searched the volume in question, indeed the entire series of the 'Proceedings,' but cannot find any mention whatsoever of an *A. melbournensis*.

Douglas River, Brisbane and Ipswich, Queensland, and Eastern Creek near Chatsworth, N. S. Wales (*Brazier*).

This species, like most others in the genus, is subject to considerable variation in form. The typical shell figured in the 'Magasin de Zoologie' appears unusually globose, and exhibits very regularly curved outlines, whilst the majority of the specimens which have come under my observation display a tendency to somewhat flattened sides. This difference was considered sufficient by Conrad for specific distinction; hence he described his *L. perlevis*. It is very doubtful whether this species is a true *Amphipeplea*, upon which subject Martens (Ann. & Mag. Nat. Hist. 1866, vol. xvii. p. 212) offers some very interesting remarks.

38. Limnæa (Amphipeplea?) Phillipsi, *A. Adams & Angas*.

Amphipeplea Phillipsi, *A. Ad. & Ang. Proc. Zool. Soc.* 1863, p. 416; *Sowerby, Con. Icon.* fig. 41 *a–b*.

Limnæa Deshayesii (*Adams*), *Sowerby, Con. Icon.* fig. 95 *a–b*.

Hab. Cornet Creek and Roper's Lake, N. Australia (*Port-Essington Expedition*, 1845); Arnheim's Land (*Stuart's Expedition*).

It is difficult to draw a line between this species and *L. Lessoni*. The typical forms are very different, the latter having a very short spire, whilst that of the former is comparatively long and acuminate. But there are some varieties which appear almost intermediate with regard to the height of the spire. The specimens described by Adams and Angas have been liberally presented to the British Museum by the latter gentleman. They are, I believe, the young state of the large *L. Deshayesii*. Both were obtained from North Australia, and both exhibit the same strong spiral striation, a character entirely overlooked by Sowerby in his slovenly monograph of this genus.

39. Limnæa (Amphipeplea?) Angasi, *Sowerby*.

Limnæa Angasi, *Sowerby, Con. Icon.* fig. 11 *a–b*, species 12.

Hab. Port Darwin, North Australia.

This is closely allied to *L. Phillipsi*, but has a shorter spire, is rather more globose, more glossy, although exhibiting spiral striation, and of a brownish horny colour. Sowerby says it is "variegated by opaque white interrupted stripes. In this respect the species differs from all the other known species." This is an inac-

curacy of observation; for the "opaque white interrupted stripes" are merely accidental blemishes where the shell has been eaten into and the coloured surface removed. Of this I speak with certainty, as the actual type is in the Museum, presented by Mr. Angas.

40. Limnæa (Amphipeplea?) vinosa, *A. Adams & Angas.*

Amphipeplea vinosa, *A. Ad. & Ang. Proc. Zool. Soc.* 1863, p. 415; *Sowerby, Con. Icon.* fig. 37.

Hab. Adelaide River, North Australia (*Stuart's Expedition*).

This is remarkable for the depth of its colour. It is less acuminate in the spire and more shouldered in the body-whorl than *L. Angasi*, agreeing rather in these respects with *L. Lessoni*; but that is a larger species, somewhat more globose, and of a pale tint.

It appears to me a matter of considerable doubt whether this and the three preceding forms have, or have not, any real specific differences. In the Museum series, consisting of over a hundred and fifty specimens, I cannot draw any quite satisfactory limits. *L. vinosa* perhaps is the most easily distinguishable; for, judging from the ten examples before me, it appears to be always of a uniform vinous tint. *L. Lessoni* is the most globose of the four species, *L. Phillipsi* the most elongate, and *L. Angasi* somewhat intermediate between the two latter, and of a rather brighter colour. All exhibit more or less spiral striation. Scarcely two specimens are precisely alike, and the form of the aperture, the height of the spire, and the character of the columellar twist are subject to the greatest variation.

41. Limnæa affinis, *Parreyss.* (Plate V. fig. 14.)

Limnæus affinis, *Parreyss, Küster, Con.-Cab.* p. 55, pl. xii. figs. 5–6.

Hab. New Holland.

Of this species the British Museum possesses examples purchased of Parreyss under the above name. It is of a narrower and more ovate form than the preceding species.

42. Limnæa brevicauda, *Sowerby.* (Plate V. figs. 17–18.)

Limnæa brevicauda (*Parreyss MS.*), *Sowb. Con. Icon.* fig. 135; *Theobald & Hanley, Conchol. Indica*, p. 64, pl. clviii. fig. 7.

Hab. Australia (*Parreyss in Brit. Mus.*); Cashmere (*W. Blanford*).

This species calls to mind the European *L. auricularia*. Sowerby

represents the columella decidedly too sinuated, and his figure is unlike the shell he copied.

43. LIMNÆA SUBAQUATILIS, *Tate*.

Limnæa subaquatilis, *Tate, Trans. & Proc. Roy. Soc. South Australia*, vol. iii. p. 103, pl. iv. fig. 6 *a–b*.

Hab. River Torrens at Adelaide.

44. LIMNÆA PAPYRACEA, *Tate*.

Limnæa papyracea, *Tate, l. c. suprà*, pl. iv. fig. 5 *a–c*.

Hab. Near Penola, South Australia.

45. LIMNÆA BRAZIERI, n. sp. (Plate V. fig. 15.)

Shell ovate, acuminate above, glossy, brownish horn-colour, somewhat strongly striated longitudinally by the lines of increment, without spiral or transverse sculpture. Whorls 4, very convex, separated by a simple deepish suture. Aperture ovately pyriform, occupying about two thirds of the entire length of the shell. Columella obliquely arcuate, spirally contorted, with a flattish or even excavated margin, reflexed in the umbilical region, and connected with the lip above by a thin whitish callosity.

Length 9 millim., diam. 5½; aperture 6 long, 4½ broad.

Hab. Glebe Point, Sydney, New South Wales. On a flat rock with clear water running over them (*Brazier*).

I have much pleasure in naming this species after Mr. John Brazier of Sydney, by whom the specimens were collected, and to whom the British Museum is indebted for a very valuable series of *Physæ* and *Limnææ* from Australia, besides a collection of *Melaniæ* from several of the Pacific islands, and various other shells, all of which have special localities attached to them, which circumstance adds very materially to their interest.

46. LIMNÆA SPIRULATA, *Mousson*.

Limnæa spirulata, *Sowerby, Con. Icon.* fig. 106 *a–b*.

Hab. Australia.

This species is said by Sowerby to be described in the 'Journal de Conchyliogie,' but I fail to find the description.

47. LIMNÆA VICTORIÆ, n. sp. (Plate V. fig. 16.)

Shell narrowly ovate, turreted, brownish corneous. Whorls 4–5, convex, striated both longitudinally by the lines of growth, and transversely by somewhat indistinct spiral striæ. Spire

turreted; apex not very acute. Last whorl elongate. Aperture inversely subauriform, about half the length of the shell. Columella not much contorted, brownish, reflexed over the umbilical region, and joined to the upper lip by a thin brownish callosity. Labrum tinged with brown.

Length 6 millim., diam. $2\frac{1}{3}$.

Hab. Barnsdale, Victoria, South Australia (*W. F. Petterd*).

Of this interesting little species I have seen but two specimens, kindly placed in my hands for examination by Mr. J. W. Taylor, editor of the 'Journal of Conchology.' It is much narrower than *L. Brazieri* or any of the Australian species of this genus. Of course it is impossible to say if either of these shells be adult; but, judging from the appearance of the columella and the callosity upon it, I am inclined to believe that such is the case.

Besides the eight species above mentioned, there are in the Museum three others with the locality "Australia" attached to them; but as I am not absolutely certain that they are without doubt Australian forms, I think it advisable to await further information before describing them.

Genus Physa.

The Australian species of this genus are numerous, some of them being very interesting forms. It is excessively difficult, I may say impossible, for one residing in England, and with comparatively small collections, to arrange the specimens in specific groups, and still more difficult, either by words or figures, to convey to others the characters which mark the various forms. Therefore I hope that some resident conchologist, who has the opportunity of collecting the shells in large numbers, will take up the study of this neglected group, and, by examination of the animals and large series of shells, endeavour to discover such constant distinctions as may enable us to know the limits of the different species. Fifty-two species, including those now described for the first time, have already been characterized; but some of these are undoubtedly synonymous with others; and there is every probability that some of those now admitted as distinct would fall in the category of synonyms if I had an opportunity of examining the type specimens.

List of Australian Physæ *arranged chronologically.*

1825. Physa novæ hollandiæ, *Blainville.*
1826–30. Physa novæ hollandiæ, *Lesson*, = Lessonii, *Smith.*
1832. Physa georgiana, *Quoy & Gaimard.*
1834. —— novæ hollandiæ, *Gray*, = Grayi, *Smith.*
1839. —— ——, *Anton*, = P. marginata, *Küster.*
1844. —— marginata, *Küster.*
„ —— australis, *Koch.*
„ —— Ludwigii, *Krauss.*
1847. —— gibbosa, *Gould.*
1850. —— pectorosa, *Conrad.*
„ —— australiana, *Conrad.*
1861. —— carinata, *H. Adams.*
„ —— truncata, *H. Adams.*
„ —— obesa, *H. Adams.*
„ —— Cumingii, *H. Adams.*
1862. —— aliciæ, *Reeve.*
1863. —— Newcombi, *A. Adams & Angas.*
„ —— ferruginea, *A. Adams & Angas.*
„ —— badia, *A. Adams & Angas.*
„ —— olivacea, *A. Adams & Angas.*
„ —— concinna, *A. Adams & Angas.*
„ —— Reevei, *A. Adams & Angas.*
„ —— bonus-henricus, *A. Adams & Angas.*
1864. —— inflata, *A. Adams & Angas.*
1866. —— Hainesii, *Tryon.*
„ —— acutispira, *Tryon.*
1873. —— tenuistriata, *Sowerby.*
„ —— pyramidata, *Sowerby.*
„ —— latilabiata, *Sowerby*, = Hainesii, *Tryon.*
„ —— dispar, *Sowerby.*
„ —— proteus, *Sowerby.*
„ —— aciculata, *Sowerby.*
„ —— subundata, *Sowerby.*
„ —— Adamsiana, *Canefri*, = gibbosa, var.
1874. —— pinguis, *Sowerby*, = pectorosa, *Conrad.*
„ —— texturata, *Sowerby.*
„ —— bullata, *Sowerby.*
„ —— duplicata, *Sowerby.*
„ —— puncturata, *Sowerby.*
„ —— subinflata, *Sowerby.*
1878. —— pilosa, *Tenison-Woods.*
„ —— crebriciliata, *Tenison-Woods.*
„ —— arachnoidea, *Tenison-Woods.*
„ —— yarraensis, *Tenison-Woods.*
„ —— Kershawi, *Tenison-Woods.*
1879. —— brisbanica, *Nelson & Taylor*, = proteus, var.
„ —— Beddomei, *Nelson & Taylor.*
„ —— fusiformis, *Nelson & Taylor.*
1861. Physopsis Jukesii, *H. Adams.*

48. PHYSA NOVÆ-HOLLANDIÆ, *Blainville.* (Plate V. figs. 19–20.)

Physa novæ-hollandiæ, *Bl. Man. de Malacol.* 1825, p. 450, pl. xxxvii. figs. 3–3*a*.

Hab. New Holland.

Blainville's figures, now reproduced, which are evidently very inaccurately drawn, represent a shell of unusually large size, with a much prolonged columella and aperture. A specimen in the Museum collection, which approaches the figure considerably in form, is a variety of *P. proteus*, Sowerby (Con. Icon. fig. 43 *a*). However, the mouth is more oblique and not so prolonged inferiorly, and the apex of the spire is more acute. Another species which bears a closer resemblance to Blainville's figure is the *Aplexa aurantia* of Carpenter; but this is an inhabitant of California, and consequently, if the locality given by Blainville be correct, it is very remarkable that Australia and North America should possess species so very similar.

49. PHYSA LESSONI. (Plate V. figs. 21–22, after Lesson.)

Physa novæ hollandiæ, *Lesson, Voy. Coquille,* vol. ii. p. 332, pl. xvi. figs. 5–5″; *Küster, Con.-Cab.* p. 18, pl. ii. figs. 20–22.

Hab. Macquarie River.

The name employed by Lesson having already been assigned to a species by Blainville, I here substitute that of *Lessonii.* I have not been able satisfactorily to identify any specimens in the Museum with this species; but certain forms of *P. proteus* approach it rather closely.

50. PHYSA GEORGIANA, *Quoy & Gaimard.* (Plate V. figs. 23–24.)

Physa georgiana, *Quoy & Gaimard, Voy. de l'Astrolabe,* vol. ii. p. 207, pl. lviii. figs. 23–24; *Küster, Con.-Cab.* p. 25, pl. iv. figs. 13–14.

Hab. "Le port du Roi-Georges, à la Nouvelle-Hollande."

The figures here given are copied from the 'Astrolabe.'

51. PHYSA GRAYI. (Plate V. fig. 25.)

Physa novæ-hollandiæ, *Gray, Griffith's ed. Cuvier's Animal Kingdom,* pl. xxvii. fig. 4; *Sowerby, Con. Icon.* fig. 10.

Hab. New Holland.

In this instance Sowerby figures Gray's *P. novæ-hollandiæ*, and gives the reference to that described by Blainville under the same name. The species may eventually prove a variety of the variable *P. gibbosa.*

52. Physa marginata, *Küster*. (Plate VI. figs. 1–2, after Küster.)

Physa marginata, *Küster, Con.-Cab.* p. 10, pl. ii. figs. 1–2.

Physa novæ-hollandiæ, *Anton, Verzeichn.* p. 49. no. 1789.

"*Ph.* testa elongato-ovata, acuminata, nitidiuscula, striata, pellucida, tenuiuscula, corneo-lutescens, vertice obscuro; anfractibus 6, convexiusculis, ultimis marginibus rufis; apertura semiovata; columella alba, uniplicata." Length 22 millim.

Hab. New Holland (*Koch*).

53. Physa australis, *Koch*. (Plate VI. figs. 7–8.)

Physa australis, *Küster, Con.-Cab.* ed. 2, p. 9, pl. i. figs. 15–17.

"*Ph.* testa oblongo-ovata, subdiaphana, lævi, nitidiuscula, lutescens; spira exserta, obtusa; anfractibus subito majoribus, convexis; apertura ovata, alba, peristomate acuto, intus sublabiato; columella recta, subplicata."

Hab. West Australia.

Spire almost half the length of the shell. Lip with a thin white thickening within. The figures now given are copied from Küster.

54. Physa Ludwigii, *Krauss*. (Plate VI. figs. 9–10, after Küster.)

Physa Ludwigii, *Küster, Con.-Cab.* p. 21, pl. iii. figs. 14–16.

"*Ph.* testa irregulariter ovata, ventricosa, diaphana, tenera, corneo-lutescens; spira elongata, turrita, acuminata; anfractibus 6, subito accrescentibus, convexis, ultimo superne subplano; apertura oblonga; columella subconcava, alba, peristomate simplice, acuto, intus sanguineo-limbato."

Hab. New Holland.

Peculiar for its pointed spire and the flattened upper part of the body-whorl.

This species may hereafter be identified with *P. gibbosa*. If so, the latter name must be abandoned. The figure of *P. Ludwigii* appeared in Lieferung 47 of the 'Conchylien-Cabinet,' published in 1844; but the description was not given until 1850, in the ninetieth part. Gould's description appeared in the Boston Soc. Nat. Hist. Proceedings for 1847.

55. Physa gibbosa, *Gould*. (Plate VI. figs. 3–6.)

Physa gibbosa, *Gould, Proc. Boston Soc. Nat. Hist.* vol. ii. 1847, p. 214; *id. Wilkes's Explor. Exped., Atlas,* fig. 137; *Otia Conchol.* p. 42; *Sowerby, Con. Icon.* fig. 27.

Var. = Aplexa Adamsiana, *Canefri, Viag. Magenta*, p. 103, pl. iii. fig. 3.
Physa proteus (part.), *Sowerby, l. c.* fig. 43*c*.

Hab. New South Wales.

This species, judging from the specimens in the Museum which I consider belong to it, is very variable. The typical form has rather a short spire; but this in certain examples is much produced, so that the length above the aperture equals half the shell.

The Museum specimens are from Cook's River near Sydney, from Denbigh, Liverpool, and Parramatta. New Zealand is given by Sowerby, and is evidently incorrect.

The large form named *Adamsiana* by Canefri, of which there are several specimens in the Museum, does not, I think, exhibit any constant specific differences. It certainly presents a very different appearance to the normal *gibbosa*, lacking the shouldering or gibbosity of the last whorl, and exhibiting a comparatively elongated spire; still, in a large series, such as that before me, there are many intermediate forms; so that the conspecific relationship is apparent, and it becomes impossible to draw a line of limitation.

56. Physa pectorosa, *Conrad*. (Plate VI. fig. 11.)

Physa pectorosa, *Conrad, Proc. Acad. Nat. Sci. Philad.* 1850, vol. v. p. 11; *id. American Journ. Conch.* ii. p. 81, pl. i. fig. 6.
Var. = Physa pinguis, *Sowerby, Con. Icon.* fig. 93 *a–b*.

Hab. Bogan River (*Conrad*); Balonne River (*McGillivray*); South Australia (*Sowerby*).

The figure of this species in the 'American Journal' does not show the ventricosity of the penultimate whorl at all satisfactorily. The double fold on the columella is not peculiar to this species; for the same character, by no means a constant one, is met with in some specimens of *P. gibbosa*, *P. proteus*, and other species. *P. pinguis* differs from the typical form in having a shorter spire, which is subject to much variation in this genus.

57. Physa australiana, *Conrad*. (Plate VI. fig. 12, after Conrad.)

Physa australiana, *Conrad, Proc. Acad. Nat. Sci. Philad.* 1850, vol. v. p. 81; *id. American Journ. Conch.* ii. p. 81, pl. i. fig. 7.

"Elliptical, thin, diaphanous; volutions 4 or 5, regularly convex; spire short; epidermis amber-coloured; columella with a

slender prominent fold, which revolves within to the apex; margin of labrum regularly curved and rounded."

Hab. Bogan River, N. S. Wales.

58. PHYSA NEWCOMBI, *A. Adams & Angas.*

Physa Newcombi, *A. Adams & Angas, Proc. Zool. Soc.* 1863, p. 416; *Sowerby, Con. Icon.* fig. 21.

Hab. Pond near Mount Margaret, Central Australia (*Angas*).

This species is remarkable for the rapid enlargement of the body-whorl and the large size of the aperture. It is also umbilicated, and the great development of the labium is very unusual in this genus.

59. PHYSA INFLATA, *A. Adams & Angas.*

Physa inflata, *A. Adams & Angas, Proc. Zool. Soc.* 1864, p. 39; *Sowerby, Con. Icon.* fig. 4 *a–b.*

Hab. Wakefield River, S. Australia (*Angas*).

The types of this species, presented to the British Museum by Mr. G. F. Angas, display even greater inflation of the whorls than is represented in the figure in the 'Conchologia Iconica.'

P. Newcombi is very like this species, but it is rather longer, has a higher spire, a shallower suture, and the whorls are less swollen. The aperture, too, is not so broad and rounded, and the colour is different, being of a brownish tint, whilst that of *P. inflata* is greenish olive.

60. PHYSA BADIA, *A. Adams & Angas.*

Physa badia, *A. Adams & Angas, Proc. Zool. Soc.* 1863, p. 416; *Sowerby, Con. Icon.* fig. 51 *a–b.*

Hab. A tributary of the Adelaide River, Arnheim's Land, N. Australia (*Angas*).

This dull heavy-looking species is not unlike an elongate form of *P. pectorosa.*

61. PHYSA FERRUGINEA, *A. Adams & Angas.*

Physa ferruginea, *A. Adams & Angas, Proc. Zool. Soc.* 1863, p. 416; *Sowerby, Con. Icon.* fig. 25.

Hab. Same as the preceding species.

This species is readily distinguished from all others in the genus by the deep vinous-red colour, a character but very indifferently rendered in the figure by Sowerby.

62. PHYSA CONCINNA, *A. Adams & Angas.* (Plate VI. figs. 13–14.)

Physa concinna, *A. Adams & Angas, Proc. Zool. Soc.* 1863, p. 417; *Sowerby, Con. Icon.* fig. 35.

Hab. Arnheim's Land, N. Australia (*Angas*).

Sowerby's figure, taken from the type presented to the Museum by Mr. Angas, is not at all good. The somewhat flattened dextral outline of the body-whorl is incorrect. It should be curved, and the upper volutions are also convex. The columella, too, does not exhibit the broad white callosity portrayed in the figure. The surface is minutely decussated, the apex brownish, and the suture generally bordered by a narrow brownish line.

63. PHYSA OLIVACEA, *A. Adams & Angas.* (Plate VI. fig. 15.)

Physa olivacea, *A. Adams & Angas, Proc. Zool. Soc.* 1863, p. 416; *Sowerby, Con. Icon.* fig. 34.

Hab. Arnheim's Land, N. Australia (*Angas*).

The description in the 'Conchologia Iconica' is very misleading. Sowerby there describes the "whorls rather angular, the apical one mamillated; last whorl posteriorly angular; aperture chestnut within." On the contrary, the single specimen in the Museum, which is the type and the shell he figured, has slightly convex whorls, without the faintest indication of angulation. As the apex is eroded, a fact mentioned by Angas in his description, it is absurd to state that the apical whorl is mamillated. I presume he did not examine the specimen with a lens, but merely described the appearance to the naked eye. The last whorl also is not the least angular, and the aperture is of the same olivaceous tint as the exterior, and not chestnut. In the figure the columellar fold is placed too high up, and is much too prominent.

64. PHYSA (ISIDORA) HAINESII, *Tryon.*

Physa Hainesii, *Tryon, Amer. Journ. Conch.* ii. p. 9, pl. ii. fig. 9.

Physa latilabiata, *Sowerby, Con. Icon.* fig. 33 *a–b*.

Hab. Victoria River and Depuch Island, N. Australia.

This is a very distinct species, and readily recognized by its pallid colour and the great expansion of the peristome over the umbilicus.

65. Physa (Bulinus) acutispira, *Tryon*. (Plate VI. fig. 16, after Tryon.)

Physa (Bulinus) acutispira, *Tryon, American Journ. Conch.* vol. ii. p. 9, pl. ii. fig. 10.

"Shell cylindrically ovate, elongated, very thin, transparent, highly polished; spire elevated, very acute, suture slightly impressed; whorls 5, oblique, slightly convex; aperture narrow-ovate, two thirds the total length; columella a little folded, and somewhat turned back at the base. Very light horn-colour."

Length 12 millim., diam. 6.

Hab. Australia.

66. Physa pyramidata, *Sowerby*. (Plate VI. fig. 17.)

Physa pyramidata, *Sowerby, Con. Icon.* fig. 62.

Hab. Flinder's Island, Bass's Straits (*J. Milligan*); Victoria, S. Australia (*Brazier*).

Both the figure and description of this species are bad. The former represents the penultimate whorl not sufficiently convex, the aperture too large, and the columellar fold too prominent. The description may thus be emended:—

Shell solid, livid horn-colour, pyramidal; spire produced; whorls 7, rather convex, the penultimate somewhat inflated, the last, elongate, a little ventricose. Aperture auriform, of the same colour within as the exterior, but with a broad purplish-brown stain within the lip, which extends along the base and gradually becomes broader. Columellar fold not at all prominent, unless the shell is turned so that the eye sees far within the aperture.

67. Physa dispar, *Sowerby*.

Physa dispar, *Sowerby, Con. Icon.* fig. 66 *a–b*.

Hab. Sydney (*Sowerby*); Swan River (*Mus. Cuming*).

68. Physa aciculata, *Sowerby*.

Physa aciculata, *Sowerby, Con. Icon.* fig. 59.

Hab. New South Wales.

A very distinct species, on account of the great length of the spire.

69. Physa subinflata, *Sowerby*.

Physa subinflata, *Sowerby, Con. Icon.* fig. 6 *a*, species 5.

Hab. South Australia (*Sowerby*).

70. PHYSA PROTEUS, *Sowerby*.

Physa proteus, *Sowerby, Con. Icon.* fig. 43 *a–b* (non *c*, = gibbosa, *Gould*).

Var. jun. = P. brisbanica, *Nelson & Taylor, Journ. Conch.* ii. p. 288, pl. i. fig. 7 (bad).

Hab. North, East, and South Australia.

This species seems to be pretty generally distributed; for in the Museum there are specimens from the River Isaacs, Moreton Bay, Adelaide, Brisbane, Adelaide River, Murray River, and Rockhampton.

It is extremely variable in form, and the length of the spire differs most remarkably in series of specimens from the same locality. Very probably certain varieties will eventually prove to be the *P. novæ-hollandiæ* of Blainville and the *P. Lessonii* (*novæ-hollandiæ*, Lesson).

The shell described under the name of *P. brisbanica*, which has been submitted to me for examination, appears to be the young state of a variety of this species. The figure of it represents the spire too long and much stouter.

71. PHYSA SUBUNDATA, *Sowerby*.

Physa subundata, *Sowerby, Con. Icon.* fig. 61.

Hab. St. Margarets, South Australia (*Sowerby*); Cardwell, Rockingham Bay, Queensland (*Brazier*).

The colour of this species, judging by the figure and specimens sent by Mr. Brazier to the Museum, is rather pale horn-colour than "olive-brown" as described by Sowerby. The spiral striation will distinguish this species from *P. pectorosa*, which it somewhat resembles in form.

72. PHYSA TENUISTRIATA, *Sowerby*.

Physa tenuistriata, *Sowerby, Con. Icon.* fig. 85.

Hab. Torrens River, South Australia (*Sowerby*).

73. PHYSA TEXTURATA, *Sowerby*.

Physa texturata, *Sowerby, Con. Icon.* fig. 95.

Hab. South Australia (*Sowerby*); Sutton Grange, Victoria (*R. Etheridge*).

The extreme upper margin of the whorls is bordered with a fine white thread-like line, beneath which there is a narrow dark band. The light brownish stripe within the aperture is an internal thickening.

74. Physa bullata, *Sowerby*.

Physa bullata, *Sowerby, Con. Icon.* fig. 97.

Hab. South Australia (*Sowb.*); Botanic Gardens, Sydney (*Brazier*).

The whorls are $5\frac{1}{2}$ in number, whereof the three or four upper ones are conspicuously small. Perhaps only a variety of *P. gibbosa*.

75. Physa duplicata, *Sowerby*.

Physa duplicata, *Sowerby, Con. Icon.* fig. 100.

Hab. Wide Bay, Australia (*Sowb.*).

76. Physa puncturata, *Sowerby*.

Physa puncturata, *Sowerby, Con. Icon.* fig. 91 *a–b*.

Hab. Australia (*Sowb.*).

77. Physa fusiformis, *Nelson & Taylor*. (Plate VI. fig. 18.)

Physa fusiformis, *Nelson & Taylor, Journal of Conchology*, vol. ii. p. 289, pl. i. fig. 9.

Hab. Richmond River, New South Wales.

This species, the types of which have been kindly submitted to me for examination, exhibits the usual striæ of growth, and transverse rather remote puncture-lines. The whorls are six in number, slightly convex, and separated by a very oblique suture. The lip, viewed laterally, appears arched and prominent in the middle, and feebly sinuated near the suture. The figure in the 'Journal of Conchology' represents the body-whorl too convex on the left side and the aperture a trifle too long.

78. Physa Beddomei, *Nelson & Taylor*. (Plate VI. fig. 19.)

Physa Beddomei, *Nelson & Taylor, Journal of Conchology*, 1879, vol. ii. p. 289, pl. i. fig. 8.

Shell elongate, slender, semitransparent, pale horn-colour, at long intervals with yellowish stripes marking stages of growth, generally coated with a very black earthy deposit. Spire slender, regular; apex acute, brown. Whorls 7–8, moderately convex, regularly increasing, divided by a rather oblique suture, bordered above by a very narrow thread-like white line, rather coarsely striated by the lines of increment, which are minutely decussated by excessively fine spiral striæ. Last whorl but little inflated, stained with rich brown within the aperture at the base of the columella. Aperture narrow, sometimes hardly about as long as, or a little longer than, half the shell; labrum, viewed laterally,

arcuate and prominent in the middle, a little sinuated near the suture, and receding towards the base. Columellar twist thinnish, moderately prominent, covered with a greyish callosity, which is reflexed in the umbilical region and extends to the lip above.

Length 18 millim., greatest diam. $7\frac{1}{2}$; aperture $8\frac{1}{2}$ long, $3\frac{1}{2}$ wide.

Hab. Townsville, Queensland (*Pettard*); Cleveland Bay, Queensland (*Brazier*); Clarence River, N. S. Wales (*Strange*).

Both those from the latter locality in the Cumingian Collection and the three specimens sent by Mr. Brazier are covered with a very black earthy deposit. *P. acutispira*, Tryon, is a smaller species with a much shorter spire. The spiral striæ vary in distinctness, in some examples being scarcely observable. In Messrs. Taylor and Nelson's figure the whorls are rather too convex.

79. PHYSA GRACILENTA, n. sp. (Plate VI. fig. 20.)

Shell narrow, elongate, yellowish horn-colour, sometimes striped at intervals with opaque yellow periodic marks of growth upon the last whorl. Volutions 6, a little convex, regularly but rapidly enlarging, very faintly constricted beneath the suture, striated by the lines of growth and minute interrupted striæ in the same direction, which give the surface a very finely wrinkled appearance, visible only under a lens. Aperture narrow, inversely auriform, pale bluish or pinkish white within, generally less than half the length of the shell. Columellar fold distinct, thickish, united to the upper termination of the outer lip by a thin callosity. Labrum, viewed laterally, much curved in the middle, slightly sinuated close to the suture, and very receding at the lower part.

Length 16 millim., greatest width 6.

Hab. Endeavour Creek or River, Queensland.

This species is of a more opaque texture than *P. Beddomei*, and has fewer and more rapidly enlarging whorls. It is also of a different colour, has a less shining surface, lacks the brown stain at the base of the last whorl seen within the aperture, and the columella is thicker.

Five out of six specimens before me have the apex of the spire broken or naturally eroded, leaving but four of the whorls remaining.

80. Physa producta, n. sp. (Plate VI. fig. 21.)

Shell elongate, of a yellowish olivaceous colour, somewhat strongly striated by the lines of growth; spire elongate, acuminate. Whorls 6–7, convex, regularly increasing, the last sometimes faintly constricted beneath the suture, which is very oblique and occasionally narrowly marginate. Last volution elongate, a little inflated. Aperture obliquely inversely auriform, acute above, generally less than half the entire length of the shell, but sometimes longer. Columellar fold thin, moderately prominent, white. Callus on the paries thin, extending to the lip above. Labrum, viewed laterally, obliquely arcuate, very slightly sinuated near the suture.

Length 26 millim., diam. 10; aperture $12\frac{1}{2}$ long, 5 broad.

Hab. South Grafton, Clarence River (*Brazier*); Hunter River (*Dr. A. Sinclair, R.N.*).

This species is rather narrower in the body-whorl than *P. gibbosa*, var. *Adamsiana*, Canefri, and those of the spire are perhaps more regular in their enlargement. The colour, too, is not so olivaceous, being rather yellower in tint. *P. attenuata*, Sowerby, from Tasmania, has a less acuminate spire, and the body-whorl is conspicuously narrow in proportion to the preceding whorls. *P. gibbosa*, however, may eventually include this species, as certain slender forms approach it very closely.

81. Physa Brazieri, n. sp. (Plate VI. fig. 22.)

Shell short, ovate, subglobose, glossy, pellucid, horny brown, striated feebly by the lines of growth, and crossed by spiral, more or less punctate striæ, some of which are rather remote. Whorls 4, rapidly enlarging, convex; last large, subglobose. Aperture broadly subauriform, acutish above, rounded below, occupying about two thirds of the whole length. Columella simple, arcuate, exhibiting no fold, covered with a greyish callosity extending to the lip above and reflexed in the umbilical region, thus producing a narrow rimation. Labrum, viewed laterally, almost straight, not arcuate in the middle.

Length 12 millim., greatest diameter $7\frac{1}{3}$; aperture $7\frac{1}{2}$ long, 4 broad.

Var. *a.* Shell of a pale horn-colour.

Var. *b.* Shell larger than type, spire a little shorter, aperture a little longer. Colour of a pale horn tint.

Hab. Ashfield, near Sydney (*Brazier*).

a. Var. *pallida.* Rooty Hill, near Chatsworth, N. S. Wales (*Brazier*).

b. Var. *major.* Burnett River, Queensland (*Brazier*).

This is a pretty glossy species, of a bright horn-brown colour, and, like *P. inflata*, characterized by the absence of a twist or fold on the columella. However, it is less inflated than that species, of a different colour, has a longer spire, and the suture is not so deep. I feel much pleasure in naming this interesting form after Mr. John Brazier of Sydney, to whom the British Museum is indebted for a very valuable series of freshwater shells from Australia and some of the Pacific islands, besides many curious marine species from these localities. *P. subinflata* of Sowerby is very like this species; but the columella presents a slight twist, and its dimensions are greater.

82. Physa queenslandica, n. sp. (Plate VI. fig. 23.)

Shell small, semitransparent, acuminate above, light horn-colour, not very glossy, somewhat coarsely striated by the lines of growth, and exhibiting at times indications of spiral striæ, chiefly at the upper part of the whorls near the suture. Spire acute; apex small, brown. Whorls 6, narrowly bordered with white, rather convex, pretty regularly increasing; last long, only a little inflated. Aperture narrow, occupying rather less than three fifths of the entire length, acute above, with a brown stain at the base, sometimes extending parallel with the lip to its junction with the whorl, and a little thickened. Columellar fold inconspicuous, narrowly reflexed, whitish. Lip like that of *P. Beddomei.*

Length $12\frac{1}{2}$ millim., greatest diameter $6\frac{1}{3}$; aperture 7 long, $2\frac{3}{4}$ wide.

Hab. Dawson River, Queensland (*Brazier*).

This species differs from *P. Beddomei* in being smaller, in having a shorter and more suddenly acute spire and a less pronounced columellar twist. The colour is similar, but the black pseudo-epidermis is wanting.

Tryon's *P. acutispira* appears to be more "highly polished," without the basal brown mark, and a little longer in the aperture; still, on comparison, it may eventually prove to be the same as the present species. *P. fusiformis*, Nelson & Taylor, has a narrower body-whorl, and is sculptured with strongly punctured striæ.

83. Physa Quoyi, n. sp. (Plate VI. fig. 24.)

Shell elongate, narrow, pale horn-colour, scarcely semitransparent, not very glossy, striated moderately distinctly by the lines of growth. Spire somewhat produced, rather suddenly diminishing, and becoming acute above the penultimate whorl. Apex brown, small. Whorls 6, convex, penultimate inflated, very oblique; last subcylindrical, narrow, convex, rather rapidly descending near the lip. Aperture small, inversely subauriform, narrow, less than half the soell in length, feebly stained with brown within at the base. Lip, viewed laterally, very oblique, having an almost straight edge, and exhibiting scarcely any arcuation or sinuosity. Columellar fold rather high up, not prominent, reflexed, thus producing an umbilical rimation.

Length 15 millim., greatest diameter 6; aperture 7 long, 3 broad.

Hab. King George's Sound, South-west Australia (*Brazier*).

This species is remarkable for the cylindrical body-whorl and manner in which it descends on approaching the aperture; the latter, too, is small, and the sutural line very oblique. The species is named after one of the authors of the molluscan portion of the 'Voyage de l'Astrolabe,' who has described the only other species hitherto known from the south-western part of Australia.

84. Physa Etheridgii, n. sp. (Plate VI. fig. 25.)

Shell small, ovate, acute, very pale horn-colour and transparent, streaked at intervals longitudinally with opaque creamy stripes, brownish at the apex. Spire rather acute, frequently eroded at the tip. Whorls 4–4½, convex, rapidly increasing; last narrow, ovate, somewhat attenuated at the base. Aperture elongate, auriform, narrow, occupying nearly three fourths of the entire length of the shell. Columellar twist rather high up, thin. Labrum oblique, arcuate in the middle, and feebly sinuated beneath the suture. Sculpture consisting of fine lines of growth and more or less indistinct spiral striæ.

Length 11 millim., greatest diameter 6; aperture 7 long, 3 wide.

Hab. Yan-Yean Reservoir, Plenty district, Victoria, S. Australia (*Etheridge*).

This species resembles in some respects *P. acutispira*, Tryon. The spire, however, appears to be not so slender, and the colour also is different. The opaque creamy stripes seem to be a character

not met with in *P. acutispira*; there are three or four of them on the last whorl.

I name this species after my friend and colleague Mr. Etheridge, by whom the specimens were collected and presented to the Museum.

85. PHYSA PILOSA, *Tenison-Woods.*

Physa pilosa, *Tenison-Woods, Trans. Roy. Soc. Victoria,* 1878, vol. xiv. p. 63.

Shell subumbilicated, thin, glossy, inflated, obliquely broadly ovate, milky white or fulvous, subpellucid; whorls 3, last inflated and oblique, two apical ones small, acute, regularly longitudinally striated; periostraca luteous, with regular pilose or punctate lines; suture coronated; aperture oblique, ovate, produced anteriorly; labrum thin; labium reflexed.

Lat. 6 mill., long. 11.

Hab. Melbourne.

"This may possibly be only a variety of *P. crebriciliata.* It differs from it in being thinner, lighter in colour, with a very thin periostraca—the extremely small spire, with the oblique and inferiorly produced aperture."

86. PHYSA ARACHNOIDEA, *Tenison-Woods.*

Physa arachnoidea, *Tenison-Woods, Trans. Roy. Soc. Victoria,* 1878, vol. xiv. p. 63.

Shell elongately ovate, or subcylindrical, rather solid, opaque, shining or clothed with a periostraca; shell brown or yellow, with white spots; apex acute. Whorls 6, rapidly decreasing, slightly convex and sloping, striate lengthwise and transversely; striæ granularly dotted, which is only visible under the lens, dots disposed in spiral lines. Aperture oblique, pyriform, produced anteriorly, chalky white inside; plait thick, but visible only by looking, as it were, upwards through the umbilicus.

Long. 12 mill., lat. 5½; long. apert. 7, lat. 3½.

Hab. Mordialloc, Victoria.

"This species is probably ciliated in the young or fine condition."

87. PHYSA YARRAENSIS, *Tenison-Woods.*

Physa yarraensis, *Tenison-Woods, Trans. Roy. Soc. Victoria,* 1878, vol. xiv. p. 64.

"Shell subumbilicate, thin, diaphanous, pale horny, shining;

spire acute; whorls 4, convex, sloping, two spiral ones small, finely striate lengthwise; aperture elongate, pyriform; labrum very thin, produced anteriorly; lip inconspicuous; plait a little thickened."

Hab. Upper Yarra, Victoria.

"A shell with no very determinate characters, of small size, and thin."

88. Physa Kershawi, *Tenison-Woods*.

Physa Kershawi, *Tenison-Woods, Trans. Roy. Soc. Victoria,* 1878, vol. xiv. p. 64.

Shell small, narrowly ovate, clothed with a sordid rugose periostraca, slightly diaphanous, dusky in colour; whorls $3\frac{1}{2}$ to 4, conspicuously angulate, and flattened above, at the angle (and on the last whorl distinctly) keeled; keels rounded, raised; at the suture narrowly canaliculate; aperture oval, produced anteriorly; labrum thin, sinuous at the keels; inner lip reflexed, subumbilicate.

Long. 8 mill., lat. $4\frac{1}{2}$.

Hab. Upper Yarra, Victoria.

"There is a faint resemblance between this shell and the New-Zealand *P. tabulata* of Gould."

89. Physa crebreciliata, *Woods*.

Physa crebreciliata, *Tenison-Woods, Trans. Roy. Soc. Victoria,* 1878, vol. xiv. p. 63.

"Shell umbilicate, thin, inflated, broadly ovate, horny, dusky, or whitish, and diaphanous, completely covered with a ciliated periostraca; whorls $3\frac{1}{2}$, the two apical ones small, the penultimate very oblique, thickly striate lengthwise, and furnished with close spiral ciliated lines; sutures crowned by the periostraca; aperture broadly ovate, slightly thickened or bilabiate; lips conspicuously reflexed."

Long. 7 mill., lat. 15.

Hab. Caulfield, Melbourne.

"The cilia in this shell are in regular equidistant spiral lines, and at the sutures the periostraca seems to mass itself in small rough folds, so as to make a spinous ridge."

90. Physa breviculmen, n. sp. (Plate VI. fig. 26.)

Shell narrowly ovate, semitransparent, sometimes more opaque, light brownish horn-colour, with two or three periodical opaque creamy stripes on the last whorl. Apex minute, dark brown.

Suture with a fine white line beneath. Whorls $4\frac{1}{2}$–5; three first very small, only a little convex, penultimate very swollen; last rather inflated above, subcylindrical. Sculpture consisting of lines of growth strongly decussated by spiral, more or less punctured, striæ. Aperture narrow, occupying rather less than two thirds the entire length of the shell, broadly margined with brown within the lip; the latter is oblique, a little arched in the middle, and faintly sinuated towards the suture. Columella oblique, straightish, with only a slight and not prominent twist.

Length 15 millim., greatest diameter 8; aperture $8\frac{1}{2}$ long, $3\frac{1}{2}$ wide.

Hab. King George's Sound, South-west Australia (*Brazier*).

This species is peculiar on account of its remarkably small apex, the bulging nature of the penultimate whorl, and the distinct decussated sculpture. The latter characteristic and the smaller size separate it from the *P. proteus*. *P. tenuistriata* appears to be similarly sculptured; but broader, longer in the aperture, and the whorls are said to be "slightly angular," a feature entirely absent in the present species.

91. Physa tenuilirata, n. sp. (Plate VI. fig. 27.)

Shell acuminately ovate, olivaceous horn-colour, usually with one or more periodic yellowish stripes upon the last whorl. Volutions 5, convex; three apical ones small, stained with dark brown, penultimate suddenly and comparatively larger; last elongate, rapidly descending. Sculpture consisting of lines of growth, and very distinct and elevated spiral wavy lines, which vary considerably in number in different specimens. Aperture narrow, exhibiting a buff or yellowish thickened ridge within the labrum, and generally another further within, occupying about five eighths of the entire length of the shell. Columellar fold scarcely defined; the callosity reflexed, whitish.

Length 12 millim., greatest diameter 6.

Hab. Swan River, W. Australia (*Mus. Cuming.*); Perth (*Petterd*).

There are several specimens of this species in the Museum, all exhibiting about the same relative proportions with regard to the length of the aperture and the total length. An example from Perth sent to me for examination by Mr. J. W. Taylor of Leeds has, however, the spire unusually elongated, so that the aperture occupies scarcely more than half the entire length.

The distinct elevated spiral lines are far less raised than in the *P. aliciæ* of Reeve, yet more so than in several other Australian forms. It is in reality a link connecting the genus *Glyptophysa* of Crosse with *Physa* proper. The lines of growth are very distinct, and, crossing the spiral lirulæ, give the surface a minutely cancellated appearance.

Two specimens from Bunyip River, Victoria, sent by Mr. Petterd to Mr. Taylor, who has submitted them to me, appear to belong to this species. They differ in being of a brownish olivaceous colour, and in having much fewer spiral lines. Neither of them present the yellowish stripe or mark of periodic growth on the last volution, which occurs in most of the examples from Western Australia.

92. Physa exarata, n. sp. (Plate VI. fig. 28.)

Shell ovately fusiform, pale horn-colour, marked with very distinct spiral striæ and lines of growth. Whorls 4, convex. Apex rather large, not acute. Last volution elongate, attenuated at the base. Aperture narrow, acute above, and rather so inferiorly. Columellar fold very slightly prominent.

Length 6 millim., diam. 3.

Hab. Depuch Island, Port Essington, N. Australia.

The specimens here described may not be adult. The species is remarkable for the comparatively large apex and the deep horizontal striæ; these are about four in number on the penultimate whorl, and eighteen on the last.

93. Physa (Ameria) carinata, *H. Adams.*

Physa (Ameria) carinata, *H. Adams, Proc. Zool. Soc.* 1861, p. 143; *Sowerby, Con. Icon.* fig. 18 *a–b.*

Hab. Boyne River, Queensland.

The aperture is feebly, indeed scarcely perceptibly, tinted with rose, and certainly not the deep rosy colour represented by Sowerby's figure.

It is questionable whether this and the four following so-called species are more than varieties of one form.

94. Physa (Ameria) truncata, *H. Adams.*

Physa (Ameria) truncata, *H. Adams, Proc. Zool. Soc.* 1861, p. 144; *Sowerby, l. c.* fig. 20.

Hab. Calliope River, Burdekin River, and Rockhampton, Queensland.

95. Physa (Ameria) obesa, *H. Adams.*

Physa (Ameria) obesa, *H. Adams, Proc. Zool. Soc.* 1861, p. 144; *Sowerby, l. c.* fig. 24 *a–b*.

Hab. Fitzroy River, Queensland.

96. Physa (Ameria) Cumingii, *H. Adams.*

Physa (Ameria) Cumingii, *H. Adams, Proc. Zool. Soc.* 1861, p. 144; *Sowerby, l. c.* fig. 44.

Hab. Port Essington and Queensland.

97. Physa (Ameria) Reevii, *A. Adams & Angas.*

Physa (Ameria) Reevii, *A. Adams & Angas, Proc. Zool. Soc.* 1863, p. 417; *Sowerby, l. c.* fig. 40.

Hab. Arnheim's Land.

The colour of this species is light olive, and not reddish as it is coloured in the 'Conchologia Iconica.'

98. Physa (Ameria) bonus-henricus, *A. Adams & Angas.* (Plate VI. fig. 29.)

Physa (Ameria) bonus-henricus, *A. Adams & Angas, Proc. Zool. Soc.* 1863, p. 417; *Sowerby, l. c.* fig. 38 *a, b*.

Hab. Arnheim's Land, N. Australia.

Like the majority of the figures in Sowerby's monograph of this genus, that of the present species is altogether different from nature.

The type is of a pale olivaceous horn-colour, and not the vivid red represented in the work referred to. The form, too, is incorrectly drawn; for in neither of the two specimens in the Museum are the sides of the last whorl flattened as there delineated.

99. Physa (Glyptophysa) aliciæ, *Reeve.*

Physa aliciæ, *Reeve, Proc. Zool. Soc.* 1862, p. 106, woodcut; *Sowerby, Con. Icon.* fig. 6 *b*.

Hab. Murray and Gawler rivers, South Australia; River Onkaparinga, at Noarlunga (*Molineux*).

The description of this species by Sowerby is incorrect with regard to colour; and the locality "India" is also wrong. The shell is whitish, clothed with a pale dirty straw-coloured epidermis. The Museum possesses two specimens of an interesting variety presented by Mr. Gerard Krefft; they differ from the normal form of the species in having the spiral ridges both fewer and less elevated.

Genus PHYSOPSIS.

100. PHYSOPSIS JUKESII, *H. Adams*.

Physopsis Jukesii, *H. Adams, Proc. Zool. Soc.* 1861, p. 144; *Sowerby, l. c.* fig. 71 *a–b*.

Hab. Port Essington, N. Australia (*Jukes*).

Sowerby incorrectly quotes A. Adams as the author of this interesting species.

Genus PLANORBIS.

101. PLANORBIS GILBERTI, *Dunker*. (Plate VI. figs. 30–32.)

Planorbis Gilberti, *Dunker, Proc. Zool. Soc.* 1848, p. 40; *Sowerby, Con. Icon.* fig. 37 *a–b*.

Hab. East Australia (*Mus. Cuming*); Brisbane, Queensland (*Petterd*).

Dunker describes this species as having the whorls obtusely angular both on the upper and under sides. This feature is decidedly more conspicuous in the latter place. He also states that the acute keel is situated below the middle of the whorls; but on very careful examination of the three typical specimens in the Cumingian collection, I can affirm with certainty that it is central upon the upper whorls, and becomes a little subcentral upon the last, especially towards the aperture. All three specimens exhibit, to a small extent, fine, but not close, spiral striæ. The whorls are $3\frac{1}{2}$ in number, whereof the first two are sunken above, the last and the penultimate being almost on the same level.

102. PLANORBIS FRAGILIS, *Brazier*. (Plate VII. figs. 1–3.)

This species is more compressed than *P. Gilberti* and more acutely keeled. Being flatter, the lower surface is less sunken in the middle.

Hab. Ipswich, Queensland (*Brazier*).

The above name I have seen attached to specimens of this species sent by Mr. C. E. Beddome, of Hobart Town, to Mr. J. Taylor, of Leeds; but as yet I have not seen the published description of such a species. This form is spirally striated, in which respect it differs from *P. essingtonensis* and *P. macquariensis*, than either of which species it is more sharply carinated.

103. PLANORBIS ESSINGTONENSIS, n. sp. (Plate VI. figs. 33–35.)

Shell white, discoid, compressed, striated by lines of growth.

Spire sunken a little below the last whorl. Volutions 4, equally convex above and beneath; the last in adult specimens carinated, not very acutely, a little below or at the middle. Lower surface sunken in the centre about as much as the upper. Aperture almost horizontal.

Greatest diameter 5 millim., height $1\frac{1}{4}$.

Hab. Freshwater lagoons, Point Smith, Port Essington (*Brit. Mus.*).

This species is flatter than *P. Gilberti*, has no spiral striation, is not so much sunken beneath, and the whorls have no indication of the feeble angulation observable in that species.

104. PLANORBIS MACQUARIENSIS, n. sp. (Plate VII. figs. 4–6.)

Shell smaller than *P. essingtonensis*, not quite so compressed, more sunken in the umbilical region, less acutely keeled and corneous. Whorls $3\frac{1}{2}$. Aperture not so narrow perpendicularly as in the above-named species, and scarcely as horizontal.

Greatest diameter $4\frac{1}{3}$ millim., height $1\frac{1}{3}$.

Hab. Macquarie River, New South Wales (*Rev. D. Landsborough*).

This species is smaller than *P. Gilberti*, has no faint angulation on the lower side of the last whorl, is a little less acutely keeled, and has not spiral striæ.

105. PLANORBIS OBTUSUS, *Deshayes*.

Planorbis obtusus, *Desh. MS. Mus. Cuming*; *Sowerby, Con. Icon.* fig. 39 *a–b*.

Hab. Adelaide (*Mus. Cuming*).

Although stated by Sowerby to be described in the Proc. Zool. Soc., I have searched in vain for any description of this species in that publication. Neither can I find that Deshayes has described it elsewhere. Indeed the only ground for including it in the Australian fauna rests upon the fact that four specimens in Cuming's collection have a label "Adelaide" attached to them.

Sowerby's figure 39 *b* is very incorrect. The shell is represented as acutely keeled at the base, the keel terminating at the aperture, which appears flat beneath. This is not the case in any of the four shells in the Museum. The whorl also on the left-hand side appears to slope very much, forming a somewhat acute angle at the base.

The last whorl in reality has a slight and not prominent carina

a little above the base, and beneath it is convex; and on the left the lateral outline is less oblique than Sowerby represents it. The aperture is equally curved at the base and above, and the subbasal keel scarcely affects the curve of the right margin.

106. Planorbis spirorbis, *Müller*.

Hab. Great Britain and Europe. North Australia (*Mus. Cuming*).

There are two tablets containing several specimens of this species in the Cumingian collection labelled North Australia; and it is for this reason that I include it in the Australian list. If there had been but a single set of them, I should have been inclined to think that possibly the label had been misplaced; but since there are two series, it becomes more probable that they are indeed Australian examples.

Genus Segmentina.

107. Segmentina australiensis, n. sp. (Plate VII. figs. 7–10.)

Shell dextral, glossy, chestnut, rather acutely keeled a little below the middle of the last whorl, obliquely convex above the keel, and rather flattened at the base. Spire sunken in the middle. Whorls 4, convex, separated by a deep suture. Umbilicus deepish, occupying about one third of the diameter of the base. Aperture horizontal, much encroached upon by the whorl, flat at the base, rather acute on the right.

Greatest diameter 5 millim., smallest diameter 4, height $1\frac{1}{3}$.

Hab. Penrith, N. S. Wales (*M'Gillivray, Voyage of the 'Rattlesnake'*).

The internal lamellæ are somewhat difficult of observation through the shell. Those nearest the aperture are situated at about one third of the extent of the whorl from the peristome; they are three in number, whereof the basal one is the largest, that upon the parieties next in size, and the third (upon the outer wall of the whorl above the keel) the smallest.

The rich chestnut colour, the very glossy surface, and especially the flat under-surface are the chief characteristic points of this interesting species.

108. Segmentina victoriæ, n. sp. (Plate VII. figs. 11–13.)

Shell like *S. australiensis*, but not so flattened beneath; last

whorl proportionally larger, and the sunken spire smaller; umbilicus narrower; internal lamellæ none.

Greatest diameter 4 millim., smallest diam. $3\frac{1}{2}$, height $1\frac{1}{3}$.

Hab. Victoria; S. Australia.

In colour and general aspect this species closely resembles the preceding. On careful comparison, however, it proves to differ in the particulars above referred to. It appears inconsistent to place a shell in the genus *Segmentina* lacking the essential character of internal lamellæ. However, its *tout-ensemble* is so Segmentinoid, that I feel sure it is an abnormal form of that group.

Genus Ancylus.

109. Ancylus australicus, *Tate*? (Plate VII. figs. 36–37.)

Ancylus australicus, *Tate ?, Trans. & Proc. Roy. Soc. South Australia,* vol. iii. 1880, p. 102, pl. iv. fig. 4 *a–b*.

Hab. North Australia: collected during the Port-Essington Expedition, October 14th, 1844. River Torres, Adelaide (*Tate*).

The two specimens in the British Museum from North Australia (*vide* figs. 36–37) appear to agree fairly with Mr. Tate's description; but a comparison with authentic examples of the species will be necessary to prove their identity.

Genus Neritina.

Of this genus, as far as I can ascertain, only two species undoubtedly live in fresh water, namely *N. crepidularia* and *N. pulligera.*

110. Neritina crepidularia, *Lamarck.*

For the synonymy of this species see Martens, Conch.-Cab. p. 37.

Hab. "Inlet next to Percival Bay, fresh water" (*Dr. Richardson*); Port Essington (*Capt. Wickham, R.N., and J. B. Jukes*); Swan River (*Brit. Mus.*); swamp two miles north of Cardwell, Queensland (*Brazier*). O-Taïti (*Lesson*); Katow River, New Guinea, on trees and roots (*Brazier, Proc. Linn. Soc. N. S. W.* 1875, p. 22).

111. Neritina pulligera, *Linn.*, var. sulcata, *Ten.-Woods.*

Neritina pulligera, *Linn.*, var. sulcata, *Ten.-Woods, Proc. Linn. Soc. N. S. Wales,* 1878, iii. p. 3.

Hab. In the mountain-streams of the Bellenden Kerr ranges, North Queensland.

112. Neritina oualaniensis, *Lesson*.

Neritina oualaniensis, *Lesson, Voy. Coquille, Zoologie*, vol. ii. p. 379.
For synonymy see Martens in Küster's Con.-Cab. p. 193.

Hab. Port Essington (*J. B. Jukes*).

This species is widely distributed from the Indian Ocean to the South Pacific, and is a marine form.

113. Neritina Dringii, *Récluz**.

Neritina Dringii, *Récluz*; *Reeve, Con. Icon.* pl. xxix. fig. 132 *a-b*.
Nerita Doingii, *Récluz, Proc. Zool. Soc.* 1845, p. 121.

Hab. Hanover Bay, N. Australia (*T. E. Dring*).

This species may be only a variety of the preceding, and is probably marine.

114. Neritina Rangiana, *Récluz*.

Nerita Rangiana, *Récluz, Revue Zoologique Soc. Cuvier*, 1841, p. 339; *Reeve, Con. Icon.* fig. 142 *a–b* (Neritina); *Angas, Proc. Zool. Soc.* 1871, p. 95.
Nerita viridis, var. major, *Rang, Bull. Sci. Férus.* 1827, vol. x. p. 412.

Hab. Port Jackson harbour (*Angas, l. c.*); Darnley Island, Torres Straits, 25–30 fms., and New Hebrides (*Brazier*); island of Negros, Philippines (*Cuming*); Madagascar (*Récluz*).

115. Neritina Souverbiana, *Montrouzier*.

Neritina Souverbiana, *Montrouzier, Journ. Conch.* 1863, vol. xi. pp. 75 & 175, pl. v. fig. 5; *Martens, Con. Cab.* p. 251, pl. xxiii. figs. 29–31.
Neritina (Vitta) pulcherrima, *Angas, Proc. Zool. Soc.* 1871, p. 19, pl. i. fig. 25.

Hab. New Caledonia (*Montrouzier*); Port Jackson (*Angas*); Cape Grenville, N.E. Australia, 20 fms., Cape York, 7 fms., and Darnley Island, 5–30 fms. (*Brazier*).

116. Neritina tritonensis, *Le Guillou*.

Neritina tritonensis, *Le Guillou*; *Reeve, Con. Icon.* fig. 68 *a–b*.

Hab. North Australia.

117. Neritina Baconi, *Reeve*.

Neritina Baconi, *Reeve, Con. Icon.* fig. 127.

Hab. Swan River (*Dr. Bacon*).

* Although Récluz in P. Z. S. 1845 quotes the collector and names the species *N. Doingii*, we have reason to suspect this to be a clerical error.

118. NERITINA AURICULATA, *Lamarck.*

The species is quoted by Reeve as Australian, but without any authority; and it is probably not an inhabitant of the continent.

119. NERITINA PRICHARDI, *Dohrn.*

Neritina Prichardi, *Dohrn, Proc. Zool. Soc.* 1861, p. 206, pl. xxvi. fig. 2; *Martens, Con. Cab.* p. 159, pl. xvi. figs. 24–26.

Hab. North Australia (*Mus. Cuming*); Fiji Islands (*Dohrn*).

There are three specimens of this species in the Cumingian collection marked North Australia. They are much eroded on the spire, and present only a slight indication of the raised ridge from which the tubulous spines arise in the normal form, and only one of them exhibits a single short spine. In other respects they are identical.

120. NERITINA LEACHII, *Récluz.*

Neritina Leachii, *Récluz, Rev. Zool.* 1841, p. 312; *Proc. Zool. Soc.* 1843, p. 199.

Hab. New Holland.

Genus NAVICELLA.

121. NAVICELLA ENTRECASTAUXI, *Récluz.*

Navicella entrecastauxi, *Récluz, Revue Zoologique,* 1841, p. 380; *Reeve, Con. Icon.* fig. 32 *a–b.*

Hab. Point Entrecastaux, King George's harbour, S.W. Australia.

Genus CORBICULA.

The species of this genus are excessively difficult of determination; and without accurate knowledge of exact localities and a good series of specimens, it is very troublesome to define with any degree of precision what may be the essential characters of the different forms. Of the nine species enumerated, two (*C. debilis* of Gould and *C. baronialis* of Prime) are known to me only by description or a figure.

122. CORBICULA OVALINA, *Deshayes.* (Plate VII. figs. 24–25.)

Corbicula ovalina, *Deshayes, Proc. Zool. Soc.* 1854, p. 343; *Cat. Conch. Brit. Mus.* p. 229; *Prime, Cat. Corb., Amer. J. Conch.* vol. v. p. 134; *Clessin, Conch. Cab.* p. 203.

Cyrina ovalina, *Desh., Sowerby, Con. Icon.* fig. 77.

Hab. Port Essington.

Sowerby's figure is both badly drawn and coloured, and the description is also incorrect. The sulci are coarser than there represented, the epidermis is blacker, and the posterior side is not "broadly truncated," but curved.

123. Corbicula prolongata, *Prime.*

Corbicula prolongata, *Prime, Journal de Conch.* vol. ix. p. 356, vol. x. p. 389, pl. xiv. fig. 6; *Cat. Corbic., Amer. Journ. Conch.* vol. v. p. 135; *Clessin, Con. Cab.* ed. 2, p. 191, pl. 38. fig. 1.

Cyrena prolongata, *Prime, Sowerby, Con. Icon.* fig. 94.

Hab. Wide Bay, East Australia.

This species, published in 1861, figured and redescribed in the following year, and since twice quoted in catalogues of the genus by Prime, is stated by Sowerby to be "— ? MS. Hanley's collection," a statement characteristic of this careless monograph.

124. Corbicula nepeanensis, *Lesson.* (Plate VII. figs. 26–27.)

Cyclas nepeanensis, *Lesson, Voy. Coquille, Zoologie,* vol. ii. p. 428, *Atlas,* pl. xiii. fig. 14; *Sowerby, Con. Icon.* (Cyrena), fig. 75 (bad).

Cyrena australis, *Deshayes, Ency. Méthod.* 1830, *Vert.* ii. no. 12, p. 50; *Anim. sans Vert.* ed. 2, vol. vi. p. 278.

Corbicula australis, *Desh. Cat. Conchifera Brit. Mus.* p. 230; *Prime, Americ. Journ. Conch.* vol. v. Appendix, p. 128, part.

Non Cyrena australis, *Desh., Sowerby, Con. Icon.* fig. 82 *a, b.*

Hab. Nepean River, N. S. Wales (*Lesson and Brazier*); Lochinvar, Hunter River, and Port Curtis (*Brit. Mus.*); Peel River and Mulgoa, New South Wales, also Brisbane River, Queensland (*Brazier*).

This species, regarding which there is much confusion, was described by Lesson in the 'Voyage of the 'Coquille,'' the volume (vol. ii.) which contains the description bearing the date 1830 on the titlepage. The description, however, was evidently written before this, as Lesson's preface bears the date January 1828.

I think there can be no doubt that Deshayes likewise described the same shell in the 'Encyclopédie Méthodique,' which also is dated 1830, notwithstanding that he himself subsequently, in the British-Museum Catalogue, holds his species distinct. In his original description he says:—" Jolie petite coquille qui nous a été généreusement communiquée par notre ami, M. Lesson, qui l'a recueillie à la Nouvelle Hollande." From this it appears that

Lesson must have given him some specimens of his species probably before he had named it *nepeanensis*; for had it belonged to another species, we should expect to find it also mentioned in the 'Voyage of the 'Coquille." The two descriptions display certain discrepancies, however; but this is pardonable in so difficult and variable a genus. Deshayes says it is subdepressed, brown-green in the Latin diagnosis, and black-brown in the French description, with a broad orange spot within; hinge with three very small cardinal teeth.

On the other hand, Lesson describes the form as swollen, the colour brownish fawn ("faune brunâtre"), the interior rosy white at the bottom, bluish on the margins, and the hinge possessing two cardinal teeth.

One character, not mentioned by either author, consists of two purplish stains or rays which are seen in the interior, one on each side beneath the lateral teeth. Still, although not referred to in his description, Lesson depicts them, though feebly, in his figure.

Prime* and Clessin† appear to have erroneously united the *Cyrena australis* of Deshayes with the *Cyclas australis* of Lamarck. The Australian variety of the latter is, according to Lamarck, a shell only 2 or 3 millim. in diameter. It belongs to the genus *Pisum*.

The species may be described as follows:—

Shell subequilateral, transversely ovate, somewhat prominent at the umbones, and compressed at the lateral and lower margin, equally curved at both ends. Epidermis normally brownish straw-colour, sometimes darker and olive-brown; generally rather eroded at the beaks, which are reddish and a little prominent beyond the dorsal marginal curve. Concentric sculpture fine, becoming more or less obsolete on the posterior side, where the epidermis exhibits a less glossy appearance, and a number of very fine filaments crossing the concentric striæ obliquely. Ligament small, light brown. Interior of the valves bluish white, somewhat reddish or rosy towards the umbones, especially in young specimens, and at times bluish or purplish towards the margins, besides which there are two purplish stains or rays, varying in intensity in different specimens, one on each side beneath the lateral teeeth. Hinge with a large double central cardinal tooth in the right valve, with a deep triangular pit on each side of it, with a small

* Cat. Corbiculadæ, Amer. Journ. Conch. v. Append. p. 128.

† Conch.-Cab. ed. 2, p. 140.

simple tooth on the right of one pit, and a more oblique and thinner one to the left of the other, almost joining the posterior lateral tooth; the latter is about equal in length to the anterior one, both being finely serrated at the edge and striated on both sides. The left valve has a large triangular deep central pit, with a prominent tooth on each side of it, somewhat grooved or double at their apices, these again having a pit on their outsides, that on the posterior side being narrow and very oblique. Lateral teeth double, separated by a groove for the reception of the simple teeth of the opposing valve.

Largest specimen 20 millim. in width, $15\frac{1}{2}$ long, 11 in thickness. An average example is 15 millim. wide, 12 long, 7 in thickness.

125. CORBICULA MINOR, *Prime.*

Corbicula minor, *Prime, Proc. Acad. Nat. Sci. Philad.* 1861, p. 127; *Cat. Corbiculadæ,* 1863, p. 4; *Annals Lyc. Nat. Hist. N. York,* vol. viii. p. 80, fig. 29; *Cat. Corb., Amer. J. Conch.* v. p. 133, no. 63; *Clessin, Küster's Con.-Cab.* p. 176, pl. 30. fig. 24.

Hab. New Holland (*Prime*); Richmond River and Burnett River (*Brazier*).

126. CORBICULA ANGASI, *Prime.*

Corbicula Angasi, *Prime, Journ. de Conch.* 1864, vol. xii. p. 151, pl. vii. fig. 6; *Cat. Corb., Americ. J. Conch.* v. p. 128, no. 6; *Clessin in Küster's Con.-Cab.* p. 205, pl. xxxviii. fig. 3; *Sowerby, Con. Icon.* Cyrena, fig. 90 (coarse)!

Corbicula rivina, *Clessin, Con.-Cab.* ed. 2, p. 139, pl. xxv. figs. 3, 4.

Hab. Murray River, S. Australia (*Angas*); River Onkaparinga, at Noarlunga (*Molineux*).

Mr. Angas has liberally placed a series of this species in the British Museum. On removing the rust-red earthy deposit which covers them, the epidermis is of a straw-colour. The interior of the valves varies considerably in painting. Prime describes it as pale orange, and sometimes whitish; but three specimens which I have opened are of a pinkish tint, two of them being much stained with deep purple. The latter colour takes the form of a somewhat triangular spot situated in the deepest part or bottom of the valve, besides which there is a broad concentric band across the middle of the valves.

The specimens described by Clessin under the name of *C. rivina* were also collected by Angas in the Murray River.

127. Corbicula baronialis, *Prime.*

Corbicula baronialis, *Prime, Ann. Lyceum Nat. Hist. New York,* 1870, vol. ix. p. 300; *Clessin, Conch.-Cab.* ed. 2, p. 200.

Hab. Port Morton, Australia.

This species is described as ovately transverse, somewhat compressed, subequilateral, with the anterior end rounded, the posterior subtruncate. The umbones are short, the epidermis yellowish, the sulci irregular, more or less obsolete, the valves thin and white within. The length is 17 millim., width 14, diam. 9.

128. Corbicula debilis, *Gould.*

Cyrena debilis, *Gould, Proc. Bost. Soc. Nat. Hist.* 1850, p. 293; *id. U.S. Explor. Exped.* vol. xii. p. 427, *Atlas,* fig. 529 *a–b*; *id. Otia Conch.* p. 86; *Tenison-Woods, Proc. Linn. Soc. N. S. Wales,* 1878, vol. ii. p. 255.

Corbicula debilis, *Gould, Deshayes, Cat. Conch. Brit. Mus.* p. 234; *Gould, Otia,* p. 246; *Prime, Cat. Corbic., Am. J. Conch.* vol. v. p. 131.

Hab. New Holland? (*Gould, 'Otia'*); Hunter River, New Holland (*Prime*).

This species is remarkable on account of the depressed umbones and its cycladiform appearance.

129. Corbicula Deshayesii. (Plate VII. figs. 28–29.)

Shell transverse, subtriangularly ovate, inequilateral, rather prominent at the umbones; anterior end shorter, rounded at the margin; posterior a little broader than in front, frequently exhibiting a slightly acute curve at its junction with the basal curved margin. Epidermis more or less zoned with olive, bluish olive, and darker bands, with the outer edge of an orange colour. Umbones eroded, when wetted exhibiting a dark purple or violet ray. Concentric sculpture coarse on the anterior part of the valves, becoming obsolete from the middle posteriorly. Interior whitish in the umbonal region with a violet spot, pale violet at the lower margin, with a spot on the posterior edge beneath the lateral teeth, all of which and the cardinals are almost white; rest of interior dark violet zoned with a paler tint. Besides the central subtrigonal ray, many specimens exhibit two others, one on each side beneath the side teeth radiating from the apex.

Variety. Shell covered with a yellowish epidermis, zoned with light reddish bands. Interior pinkish at the margin and umbo, bluish white with darker zones elsewhere.

Width 17 millim., length 13, diameter $9\frac{1}{2}$.

Hab. Victoria River and Port Essington, North Australia.

The specimens here described were named by Deshayes *C. australis* when he compiled the British-Museum Catalogue of Corbiculidæ. They are, however, quite distinct from that species, which is the same as *C. nepeanensis* of Lesson, and in no way answer the description of *C. australis*. The peculiar colour of the epidermis, the pale lower edge of the interior, and the posterior whitish spot are very characteristic features of this species. It is more inequilateral than *C. minor*, Prime, more coarsely and regularly sculptured and differently coloured. Figures 82 *a* and 82 *b* in the 'Conchologia Iconica' may possibly be intended to represent the variety of this species clothed with a yellowish epidermis.

The locality given by Sowerby, "Isl. of Timor," applies to the *Cyclas australis* of Lamarck, and not to *Cyrena australis* of Deshayes.

130. Corbicula sublævigata, n. sp. (Plate VII. figs. 30–31.)

Shell equilateral, transversely regularly ovate, with moderately prominent beaks. Ends subequally rounded, if at all, the anterior the more sharply curved. Epidermis pale straw-colour, inclining to brown at the lower margin, and especially on the posterior dorsal slope, where there are one or two irregular corrugated ridges radiating in an irregular manner from the apex. Umbones white, not eroded, smooth. Rest of the surface finely striated; the striæ most regular and strongest anteriorly, becoming fainter upon the middle and hinder portions of the valves. Interior altogether white. Lateral teeth fine.

Width 20 millim., length 15, diameter 10.

Hab. Lochinvar, Australia (*Dr. Sinclair, R.N.*).

This species may be recognized among the Australian forms by its simplicity of colouring, its smooth white umbones, the general obsolete character of the concentric sculpture, and the one or two wrinkled ridges down the posterior dorsal slope. *C. nepeanensis* is more regularly and decidedly sculptured, scarcely as equilateral, and exhibits considerable variety of painting. *C. baronialis* agrees in colour; but, from Prime's very brief description, that species appears to be of a different form, having the posterior end subtruncated, whilst there is no trace of such a peculiarity in the present species.

Genus SPHÆRIUM.

131. SPHÆRIUM EGREGIUM, *Gould.*

Cyclas egregia, *Gould, Proc. Bost. Soc. Nat. Hist.* 1850, vol. iii. p. 292; *id. Otia Conch.* p. 86; *Wilkes, Explor. Exped.* p. 245, *Atlas*, figs. 526–526 *b*; *Prime, Append., Am. J. Conch.* v. p. 153; *Tenison-Woods, Proc. Linn. Soc. N. S. Wales*, 1878, vol. ii. p. 255.

Hab. New South Wales? (*Gould*, '*Otia*').

This is a very large species, being seven eighths of an inch in length; and it is doubtfully Australian.

132. SPHÆRIUM TRANSLUCIDUM, *Sowerby.* (Plate VII. fig. 32.)

Sphærium translucidum, *Sowerby, Conch. Icon.* fig. 46.

Sphærium novæ-zelandiæ, *part., Deshayes, Proc. Zool. Soc.* 1854; *id. Cat. Corbiculidæ Brit. Mus.* p. 273.

Hab. Palm-tree Creek, Australia.

The specimens which received the name *translucidum* were considered by Deshayes to belong to his *S. novæ-zelandiæ*; and hence it is that the locality New Holland is given in his 'Monograph of Corbiculidæ in the British Museum.'

I must here state that the figure in Mr. Sowerby's monograph is not only utterly useless, but altogether misleading. His description of the form, with the exception of the dorsal margin, which slopes on each side of the umbones, is fairly correct; but where is the acuminated anterior end in the figure? The colour is hyaline white, and the mixture of red and yellow observable in the illustration has no existence in reality.

133. SPHÆRIUM QUEENSLANDICUM, n. sp. (Plate VII. fig. 33.)

Shell hyaline white, rather inequilateral, somewhat inflated, obliquely subcircular, only a little wider than long; anterior end longer, slightly acuminated; posterior shorter, broader, obtusely curved. Ventral margin much curved. Concentric striæ very minute.

Length $3\frac{1}{2}$ millim., width 4.

Hab. Limestone Creek, Burdekin River, Queensland (*Brazier*).

More inequilateral than *S. translucidum*, longer, with more prominent umbones, more circular, with the anterior end less acuminate, and the posterior not so decidedly truncated.

134. SPHÆRIUM MACGILLIVRAYI, n. sp. (Plate VII. fig. 34.)

Shell nearly equilateral, not much inflated, transversely ovate, transparent white; anteriorly a little narrower and more acumi-

nate than at the opposite extremity, which is broadly arcuate; lower margin regularly widely arcuate. Lines of growth very fine.

Length 5 millim., width 6.

Hab. Penrith, New South Wales (*MacGillivray, Voyage of the 'Rattlesnake'*).

This species is less narrow and acuminated anteriorly than *S. translucidum*, and not truncated at the hinder end. It is more ovate and less oblique than *S. queenslandicum*.

Genus Pisidium.

135. Pisidium australe, *Lamarck*, var.

Cyclas australis, *Lamk. Anim. s. Vert.* vol. v. p. 560; *Deshayes*, ed. 2, vol. vi. p. 270; *id. Cat. Corbiculidæ Brit. Mus.* p. 285 (as *Pisum*).

Hab. Port King George, New Holland.

The typical form of this species is said by Lamarck to come from the island of Timor. Hence it seems most probable that what he considered a variety from Australia is in fact a distinct species. Carpenter*, on the authority of Gray, quotes Lamarck's species as synonymous with *Lasea rubra*, Montagu. It has been confused with the *Cyrena australis* of Deshayes by Prime; but that species is a *Corbicula* and synonymous with *C. nepeanensis*, as I have already shown.

136. Pisidium semen, *Menke*.

Pisidium semen, *Menke, Moll. Nov. Holl.* p. 40; *Deshayes, Cat. Corbiculidæ in Brit. Mus.* p. 284 (as *Pisum*); *Prime, Appendix, Am. J.Conch.* v. p. 173.

Hab. On the sand-bank of Swan River.

This species, only a little more than a line in length, is described by Menke as obliquely ovate, ventricose, with turgid umbones, clothed with a yellow corneous epidermis, paler at the margin, very finely transversely striated, and, when decorticated, white or lilac.

137. Pisidium Etheridgii, n. sp. (Plate VII. fig. 35.)

Shell slightly inequilateral, a little oblique, subcordiform, tumid, whitish, covered with a greyish cuticle; anterior end the longer, acuminated and sharply curved; posterior broadly rounded. Ventral margin regularly curved. Umbones rather prominent, with the

* 'Mazatlan Cat.' p. 108.

young shell forming a more or less distinct apical cap. Concentric striæ very fine.

Width $6\frac{1}{2}$ millim., length $5\frac{1}{2}$, diam. $3\frac{1}{2}$.

Hab. Yau-Yean Reservoir, Plenty District, Victoria, South Australia (*R. Etheridge*).

Not unlike the European *P. casertanum*, but rather less inequilateral.

Genus Unio.

Chronological List of described Species.

1818. Unio australis, *Lamarck*.
,, —— depressus, *Lamarck*.
1834. —— novæ-hollandiæ, *Gray*.
1842. —— gratiosus, *Parreyss*.
1843. —— *cucumoides*, *Lea*, = novæ-hollandiæ.
1848. —— ambiguus, *Parreyss*.
,, —— multidentatus, *Parreyss*.
,, —— *fulmineus*, *Parreyss*. = multidentatus, var.
1850. —— nepeanensis, *Conrad*.
,, —— *cultelliformis*, *Conrad*, = depressus.
,, —— *balonnensis*, *Conrad*, = ambiguus.
,, —— profugus, *Gould*.
1852. —— *Cumingianus*, *Dunker*, = novæ-hollandiæ.
1855. —— *Lessoni*, *Küster*, = nepeanensis.
,, —— rugulosus, *Charpentier*.
,, —— Shuttleworthi, *Charpentier*.
1856. —— *Shuttleworthi*, *Lea*, = Angasi.
1859. —— *mutabilis*, *Lea*, = depressus.
,, —— *vittatus*, *Lea*, = ambiguus.
,, —— Wilsonii, *Lea*.
1861. —— *philippianus*, *Küster*, = ambiguus.
1862. —— semiplicatus, *Küster*.
1863. —— Stuarti, *Adams & Angas*.
1864. —— Evansi, *Adams & Angas*.
1865. —— *moretonicus*, *Reeve*, = australis, var.
1867. —— Angasi (*Lea*), *Reeve*.
1871. —— Danellii, *Villa*.
1874. —— Jeffreysianus, *Lea*.

138. Unio Angasi, *Lea*.

Unio Shuttleworthii, *Lea* (*non Charpentier*), *Proc. Acad. Nat. Sci. Philad.* 1856, p. 94; *id. Journ. Acad. Nat. Sci. Philad.* 1858, vol. iii. p. 304, pl. xxviii. fig. 19; *Reeve's Conchol. Icon.* fig. 167.

Unio Angasi, *Lea, MS.*; *Reeve's Con. Icon.* fig. 282.

Anodon Angasii, *Sowerby*, *Con. Icon.* fig. 127.

Hab. Balonne River, Brisbane River, and River Isaacs (*Brit. Mus.*); Strangeways River, N. Australia (*Angas*).

This, the largest of the Australian species, is very elongate transversely, although in this respect it is subject to considerable

variation, as the following measurements of two specimens show. One is 127 millim. long and 65 wide, the other 124 millim. in length and 69 in width. Specimens from the river Isaacs are remarkable for having the hinder half considerably tuberculose. The nacre is sometimes entirely white, bluish, or purplish; but in nearly every instance is more or less stained at the upper part and posteriorly with livid purple, olive, or a combination of these colours, difficult to define.

The name *Shuttleworthi*, which Lea in 1856 imposed upon this species, was in the year previous employed by Küster for another species of this genus, also coming from Australia. The figure and name only of the latter appeared in 1855 in Part 147 of the 'Conchylien-Cabinet,' and the description in the following year. In his "Synopsis of the Family Unionidæ," Lea makes no mention of Küster's species. *U. Angasi*, Lea, which name can be conveniently employed for this species, was described by Reeve from what I take to be the rather young state of this form.

139. Unio depressus, *Lamarck.*

Unio depressus, *Lamarck, An. s. Vert.* ed. 2, vol. vi. p. 544; *Delessert, Recueil des Coq.* pl. xii. fig. 5; *Hanley, Recent Shells*, p. 200; *Conrad, Journ. Acad. Nat. Sci. Philad.* ser. 2, 1854, vol. ii. part 4, p. 295.

Non Unio depressus, *Reeve's Con. Icon.* fig. 81.

Unio mutabilis, *Lea, Proc. Acad. Nat. Sci. Philad.* 1859, p. 152; *Reeve, Con. Icon.* fig. 112.

Unio cultelliformis, *Conrad, Proc. Acad. Nat. Sci. Philad.* 1850, p. 10; *Journ. Acad. N. S. Phil.* 1854, p. 295, pl. xxvi. fig. 2.

Hab. Bogan River (*Conrad* and *Brit. Mus.*); River Nepean (*MacGillivray*); Brisbane Water and Murray River.

Conrad is right, I think, in uniting his *U. cultelliformis* with Lamarck's *U. depressus*. The figure in Delessert cannot, however, represent the actual type, which is described as 52 millim. long, for that delineated is only 40. Conrad's specimen is said to be 60 millim. in length, and the largest in the Museum is 77.

All the examples which I have seen have a slight sinuation near the middle of the ventral margin, and a depression radiating from the umbo to that part of the outline. The anterior muscular scar is comparatively deep for so thin a shell, and of an irregular form. A second small, but very deep pit is situated just beneath the anterior or cardinal teeth. This is shown in Delessert's figure, and also pointed out by Conrad (Journ. Acad. Nat. Sci.

p. 295). The *U. mutabilis* of Lea has this peculiarity also. The *U. depressus* of the 'Conchologia Iconica,' fig. 81, is a very distinct species, and approaches certain varieties of *U. ambiguus*, the specimen figured being from Tasmania.

140. Unio australis (*Lamarck*), *Philippi*.

Unio australis, *Lamarck, Anim. s. Vert.* ed. 2, vol. vi. p. 546; *Hanley, Recent Shells*, p. 192, pl. xxi. fig. 25; *Philippi, Abbild.* vol. iii. p. 81, pl. v. fig. 5.

Non Unio australis, *Lamk., Küster, Con.-Cab.* p. 230, pl. lxxvii. fig. 6.

Var.=Unio moretonicus, *Reeve, Con. Icon.* fig. 118.

Hab. Australia.

This species, *U. balonnensis*, Conrad, *U. ambiguus*, Parreyss, *U. vittatus*, Lea, *U. Danellii*, Villa, and *U. profugus*, Gould, are very difficult to define. The second and third, I think, are certainly the same. *U. australis*, as determined by Philippi, is very like the *U. Shuttleworthii* of Lea, but rather less elongate, agreeing with it, however, in the slight ventral sinuation and the narrower anterior end.

Lamarck's diagnosis is so brief, that it is utterly impossible to know what species he had before him. I therefore adopt Philippi's idea of it. He was the first to describe and figure a shell which he believed to be the *U. australis*. Subsequently Küster, in the 'Conchylien-Cabinet,' describes and figures under this name a shell which appears to me different from that represented by Philippi. Küster makes no reference to the latter author's work. The figure in the 'Conchylien-Cabinet' represents a specimen with a coarsely concentrically striated surface and scarcely attenuating anteriorly. On the contrary, Philippi's figure is more finely striated, and the hinder end is considerably broader than the anterior.

141. Unio ambiguus, *Parreyss*.

Unio ambiguus, *Parreyss, Philippi, Abbild.* vol. iii. Lieferung 2, 1848, p. 47, pl. iii. fig. 2; *Reeve's Con. Icon.* fig. 355; *Küster's Con.-Cab.* pl. lxxix. fig. 2.

Unio balonnensis, *Conrad, Proc. Acad. Nat. Sci. Philad.* 1850, p. 10; *id. Journ. Acad. Nat. Sci. Philad.* ser. 2, vol. ii. p. 295, pl. xxvi. fig. 3; *Lea, Synopsis*, ed. 1870, p. 103, as var. of *depressus*, Lamk.

Unio philippianus, *Küster, Con.-Cab.* p. 235.

Unio vittatus, *Lea, Proc. Acad. Nat. Sci. Philad.* 1859, p. 153; *Reeve, Con. Icon.* fig. 83.

Hab. Balonne and Bogan rivers (*Conrad*); River Onka-paringa, at Noarlunga (*Molineux*, *U. vittatus*).

The name *ambiguus* was published by Philippi in the second part of the third volume of his 'Abbildungen,' which was completed in 1851. The Lieferung in question, however, appears to be undated; but a private mark upon the copy in the British-Museum library shows that it was obtained during the year 1848, or two years previous to the publication of Conrad's *U. balonnensis*.

Philippi's figure does not represent the full size to which the species attains, for one specimen in the Museum from Melbourne has an extreme diameter of 4¼ inches. The nacre is described as bluish, becoming in the umbonal region brassy or flesh-coloured, or pale flesh-colour with brass-coloured stains. Judging from the Museum series, as a rule, the lower or ventral half of the shell is bluish white, and the umbonal region, and, indeed, frequently the upper half of the shell, is stained with a brassy-brown colour. The posterior end, especially upon the muscular scar, displays the greatest iridescence.

I fail to discover any essential difference in the *U. vittatus* of Lea. The types in the Museum from Cuming's collection are of a paler and yellower colour than usual; and consequently two or three of the dark concentric zones marking periods of growth contrast more conspicuously than in deeper-coloured specimens. The form is the same, the sculpture perhaps a trifle finer, and the surface therefore rather smooth. The teeth offer no differences; and the interior, although described by Lea as white, is in reality bluish white on the lower half and brassy brown towards the umbonal region, just as it is in the normal form represented by Philippi.

Küster changed the name *ambiguus* to *philippianus*, because the former had been employed for another species which he includes in the genus *Unio*, although described by Lamarck as a *Castalia*.

142. Unio profugus, *Gould*.

Unio profugus, *Gould, Proc. Bost. Soc. Nat. Hist.* 1850, vol. iii. p. 295; *id. Explor. Exped.* p. 429, *Atlas*, pl. xxxviii. fig. 543 *b*; *id. Otia Conch.* p. 88.

Hab. Hunter River, N. S. Wales.

This species appears to be rather narrower than *U. ambiguus*, in which respect it approaches *U. Shuttleworthi* of Lea, but it does not

narrow anteriorly like that species. The bifid cardinal tooth of the right valve, remarked upon by Gould, appears to be a character common to most of the Australian species of this genus.

143. Unio Danellii, *Villa.*

Unio Danellii, *Villa, Journ. de Conch.* 1871, vol. xix. p. 328.

Hab. Brunswick, S. Australia (*Villa*); Yarra River, Victoria (*Crosse, l. c.* p. 329).

This species is known to me only by a brief diagnosis. It may be a form of *U. ambiguus.*

144. Unio Shuttleworthi, *Charpentier.*

Unio Shuttleworthii, *Charpentier, Küster's Conch.-Cab.* Lieferung 147, 1855, explanation of plates on cover, pl. xliv. fig. 2.

Unio Shuttleworthii, *Küster,* description *l. c.,* Lieferung 150, 1856, p. 152.

Hab. New Holland.

This species appears to be very closely allied to the *U. ambiguus,* Parreyss, but differs chiefly in being proportionally much narrower in front.

145. Unio Jeffreysianus, *Lea.*

Unio Jeffreysianus, *Lea, Journ. Acad. Nat. Sci. Philad.* vol. viii. 1874, p. 23, pl. vii. fig. 20.

Hab. Australia.

The remarkable peculiarity of this species consists in the lateral teeth in both valves being single. In all other respects it agrees with *U. ambiguus.* One specimen of the latter in the British Museum has this irregularity. It is the largest example, and is stated to have been found at Melbourne.

146. Unio Wilsonii, *Lea.*

Unio Wilsonii, *Lea, Proc. Acad. Nat. Sci. Philad.* 1859, p. 153; *id. Journ. Acad. Nat. Sci. Philad.* ser. 2, vol. iv. p. 256, pl. xl. fig. 137; *Reeve's Con. Icon.* fig. 472 (Lea's figure reversed).

Hab. "Eastern branch of Isaac's plain, New South Wales." —*Lea.*

147. Unio Stuarti.

Unio (Alasmodon) Stuarti, *A. Adams & Angas, Proc. Zool. Soc.* 1863, p. 417; *Reeve's Con. Icon.* pl. xliv. fig. 279, pl. xlv. fig. 279 *a.*

Anodon Stuarti, *Sowerby, Reeve's Con. Icon.* fig. 136 *a–b.*

Hab. Lagoon near Mt. Margaret, Central Australia (*Angas*); Umbum, forty miles south of Peake (*J. Chandler*).

It is in keeping with Mr. Sowerby's work that this species should appear in 1866 as a *Unio* and in 1870 as an *Anodon*.

148. Unio rugulosus, *Charpentier*.

Unio rugulosus, *Charpentier, Küster's Con.-Cab.* 1855, part 147, pl. xliv. fig. 5; *id. l. c.* 1856, part 150, p. 154.

Hab. New Holland.

149. Unio nepeanensis, *Conrad*.

Unio nepeanensis, *Conrad, Proc. Acad. Nat. Sci. Philad.* 1850, vol. v. p. 10; *id. Journ. Acad. Nat. Sci. Philad.* ser. 2, vol. ii. p. 296, pl. xxvi. fig. 4; *Reeve's Con. Icon.* fig. 110.

Unio depressus, *Lesson, non Lamarck, Voy. Coquille,* p. 427, pl. xv. figs. 5–5 *a*.

Unio Lessonii, *Küster,* 1855, *Con.-Cab.* p. 135, pl. xxxvi. fig. 4 (copy of Lesson's figure).

Hab. Nepean River, N. S. Wales (*Conrad, Lesson,* and *MacGillivray*).

This species is readily distinguished by the coarse wrinkles upon the umbones. These in Lesson's specimen appear to be much eroded; hence this peculiarity probably escaped his notice. The form of his shell, however, with the comparatively square or truncated anterior end, corresponds with that of *U. nepeanensis*; and since the locality quoted by him and Conrad is identical, I am inclined, with the latter, to consider them belonging to the same species.

150. ~~Unio Evansi~~, *A. Adams & Angas.*

Unio (Alasmodon) Evansi, *A. Adams & Angas, Proc. Zool. Soc.* 1864, p. 39; *Reeve's Con. Icon.* fig. 285.

Hab. Lagoons of Lower Murray River, South Australia (*Angas*).

151. Unio novæ-hollandiæ, *Gray*.

Unio novæ-hollandiæ, *Gray, Proc. Zool. Soc.* 1834, p. 57; *Hanley, Recent Shells,* p. 182.

Unio cucumoides, *Lea, Trans. Amer. Phil. Soc.* 1843, vol. viii. pl. vii. fig. 2; *Reeve's Con. Icon.* fig. 89; *Küster's Con.-Cab.* p. 219, pl. lxxiv. fig. 1.

Unio Cumingianus, *Dunker, Zeitsch. f. Mal.* 1852, vol. ix. p. 53.

Hab. Richmond River and Hunter River (*coll. Cuming*); Brisbane River, N. S. Wales (*J. MacGillivray*); Macquarrie River (*Gray*).

I can positively affirm the identity of the *U. cucumoides* of Lea

and this species, as the two valves upon which Gray founded his description are now in the Museum, having been presented by him a few years ago. Upon one the locality Macquarrie River is written, and upon the other the name is in his own handwriting.

152. UNIO MULTIDENTATUS, *Parreyss.*

Unio multidentatus, *Parreyss, Philippi, Abbild.* vol. iii. p. 46, pl. iii. fig. 4; *Küster's Con.-Cab.* pl. xxxvi. fig. 5.

Var.=Unio fulmineus, *Parreyss, Philippi, l. c.* figs. 5–6; *Küster*, p. 286, pl. xcvi. figs. 2, 3.

Hab. Australia (*Parreyss*).

The differences in outline and dentition pointed out by Philippi in the two forms which he considered specific are not, I think, more than individual variations. The Museum purchased of Parreyss, in 1841, four specimens labelled *U. fulmineus*, which represent both types. The older the shell, the more *multidentate* becomes the cardinal tooth.

153. UNIO GRATIOSUS, *Parreyss.*

Unio gratiosus, *Parreyss, Philippi, Abbild.* vol. i. pl. i. fig. 5; *Küster's Con.-Cab.* p. 239, pl. lxxx. fig. 3.

Hab. Australia (*Parreyss*).

This species has a more finely corrugated surface than *U. multidentatus*, and is narrow.

154. UNIO SEMIPLICATUS, *Küster.*

Unio semiplicatus, *Küster, Con.-Cab.* p. 279, pl. xciv. fig. 4.

Hab. Australia.

A narrow form with the posterior end coarsely wrinkled.

Genus MYCETOPUS.

155. MYCETOPUS RUGATUS, *Sowerby.*

Mycetopus rugatus, *Sowerby, Conchol. Iconica,* vol. xvi. fig. 7; *Smith, Voy. Erebus & Terror,* pl. iv. fig. 1; *Clessin, Küster's Con.-Cab.* p. 205, pl. lxvii. fig. 3; *Lea, Synopsis,* ed. 4, pp. 90 & 147.

Hab. Victoria River, N. Australia (*Capt. Wickham, R.N.*, and *mus. Cuming.*).

It is very remarkable that Australia and South America should possess species so much alike as *M. siliquosus* and the above.

Pseudo-Australian Species.

The following species have, erroneously I think, been quoted as inhabiting Australia.

1. PHYSA BRUNNIENSIS, *Sowerby, Con. Icon.* fig. 99 *a–b*.
Hab. Brunni Island, Australia.
This island is situated near the south coast of Tasmania, and therefore I do not include this species among the Australian *Physæ*.

2. PHYSA APERTA, *Sowerby, Con. Icon.* fig. 88 *a–b*.
Hab. "Near Hamilton, Australia."
This species, too, like the preceding, is not Australian, the town of Hamilton being in Tasmania.

3. PHYSA SINUATA, *Gould.*
Hab. "New South Wales" (Sowerby, Con. Icon. fig. 55 *a–b*).
This species is described by Gould as having been brought from the Fiji Islands; and the locality assigned to it by Sowerby is apparently one of very many errors of this description occurring in the 'Conchologica Iconica.'

4. PHYSA TONGANA, *Quoy & Gaimard.*
Hab. "Australia" (Con. Icon. fig. 54).
The authors of this species give the Tonga or Friendly Islands as the locality of this species; and Sowerby is most probably again in error in citing Australia as the habitat; for it is unlikely that the same species of this genus occurs both in Tonga and Australia.

5. PHYSA AURICULATA, *Gassies.*
Hab. Australia (Sow. Con. Icon. pl. ix. fig. 67, pl. xii. fig. 67 *b*).
I must here correct Sowerby in stating that his figure was drawn from a specimen in the British Museum. This species was not in the National Collection at the time when his monograph was published. The locality, too, given by Sowerby is incorrect, unless he considers New Caledonia, whence the species was described by M. Gassies, to be in Australia.

6. PHYSA KANAKINA, *Gassies.*
Hab. "Kanakina," Australia (Sowerby, Con. Icon. fig. 68).
Like the preceding, this species also is an inhabitant of New Caledonia. M. Gassies imposed this name (*kanakina*) upon the species because it was met with in a locality peopled by a tribe called the "kanakas." The fact of Mr. Sowerby giving "kanakina" (an adjective) as a place situated in Australia, shows the entire

absence of care in the preparation of his monograph. The 'Journal de Conchyliologie' must have been in his hand, for the figure there given is copied, though badly as regards colour; and yet the text could not have been consulted, or such an unpardonable error could never have been committed, and such an absurdity as "the Kanakina Physa" would never have appeared.

7. Physa castanea, *Sowerby*.

Hab. Australia (Sowb. Con. Icon. fig. 86).

The shell here figured was formerly considered by Sowerby ('Genera of Recent and Fossil Shells,' *Limnea*, pl. ii. fig. 7) the *Physa castanea* of Lamarck. This is European in its distribution. As Sowerby has merely copied the original figure, and does not know in whose possession the shell now is, it appears to me unjustifiable on his part to state that it is Australian. The description of the figure, too, is incorrect, for neither in the original nor the copy of it do the whorls appear "angular." *Physa castanea* of Sowerby's 'Conchological Manual,' pl. xiv. f. 310, is, again, a distinct species.

8. Physa attenuata, *Sowerby*, *Con. Icon.* fig. 94.

Hab. Dulverton Lake, Australia.

This is a Tasmanian species, and not from Australia. Lake Dulverton is quoted by the Rev. Tenison-Woods, in his "Monograph of the Freshwater Shells of Tasmania," as the locality for *P. mamillata*, Sowerby (Proc. Roy. Soc. Tasmania, 1875, p. 73).

Ampullaria.

The two following species are not considered Australian, as the authenticity of the localities rests solely upon the statement in the 'Conchologia Iconica,' a work notable for incorrect or erroneous habitats.

9. Ampullaria polita, *Deshayes*; *Con. Icon.* fig. 35.

Hab. Port Jackson, Australia.

10. Ampullaria turbinoides, *Reeve*, *Con. Icon.* fig. 37.

11. Unio superbus, *Lea*.

Unio superbus, *Lea, Trans. Amer. Phil. Soc.* 1846, vol. ix. p. 281, pl. xlii. fig. 11; *Reeve's Con. Icon.* fig. 281.

Unio velaris, *Benson, Hanley, Bivalve Shells, Appendix*, p. 385, pl. xxiii. fig. 42.

Hab. New Holland (*Lea*), Danu-Luar River, Sumatra (*Dunker*, teste *Lea*); Bugis, Celebes (*Hanley*).

This species is erroneously considered Australian by Lea.

12. ANODONTA PURPUREA, *Valenciennes.*

Anodonta purpurea, *Valenciennes, Humboldt & Bonpland's Voyage, Zoologie,* vol. ii. pl. xlviii. bis, fig. 3; *Hanley, Cat. Recent Shells,* p. 218 *Lea, Synops.* ed. 4, p. 106; *Clessin in Küster's Conch.-Cab.* p. 77, pl. xix. fig. 1.

Hab. Philippines (*Valenciennes, Hanley, Clessin*); Australia (*Lea*).

13. CORBICULA SEMISULCATA, *Deshayes, P. Z. S.* 1854, p. 343.

Hab. Victoria River (*Deshayes*).

Prime has pointed out that this species is the same as *C. limosa* of Maton, a South-American form; and in this decision I fully concur.

14. CORBICULA OBLONGA, *Clessin.*

Hab. "Apparently Australia."

This species is merely supposed to be Australian by Clessin (Con.-Cab. p. 261), on account of its similarity in outline to other forms from that continent.

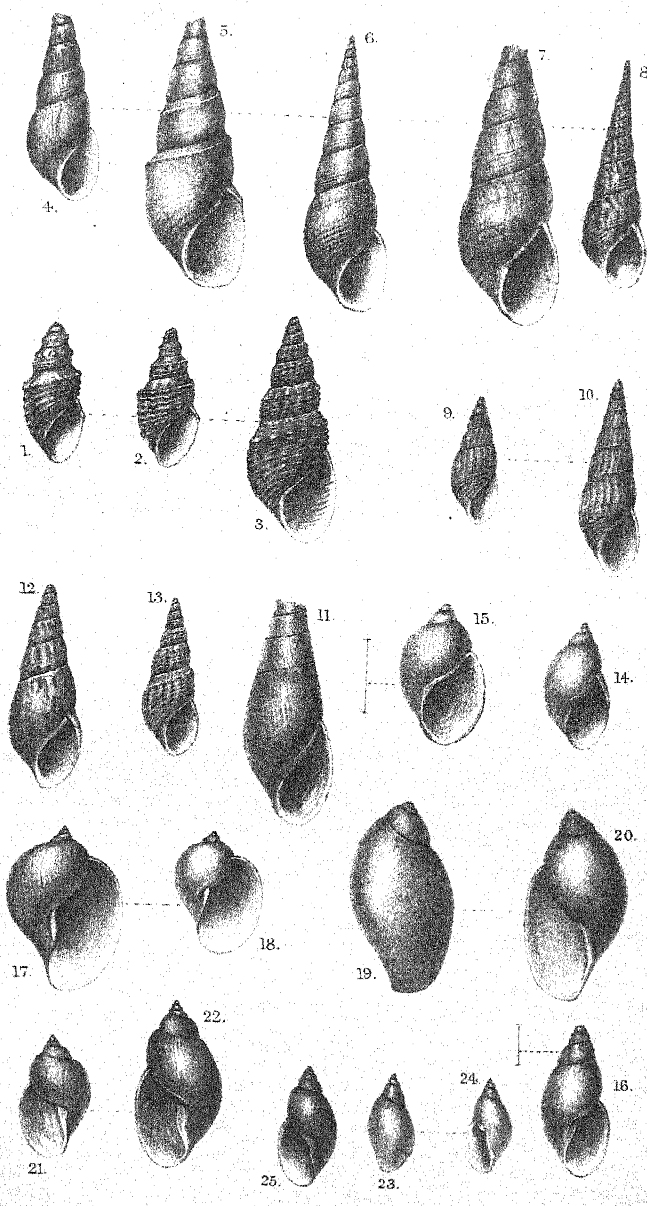
EXPLANATION OF THE PLATES.

PLATE V.

Figs. 1–3. Melania balonnensis.
4–8. M. denisoniensis.
9–10. M. venustula.
11. M. queenslandica.
12. M. Elseyi.
13. M. subsimilis.
14. Limnæa affinis.
Figs. 15. Limnæa Brazieri.
16. L. victoriæ.
17–18. L. brevicauda.
19–20. Physa novæ-hollandiæ.
21–22. P. Lessoni.
23–24. P. georgiana.
25. P. Grayi.

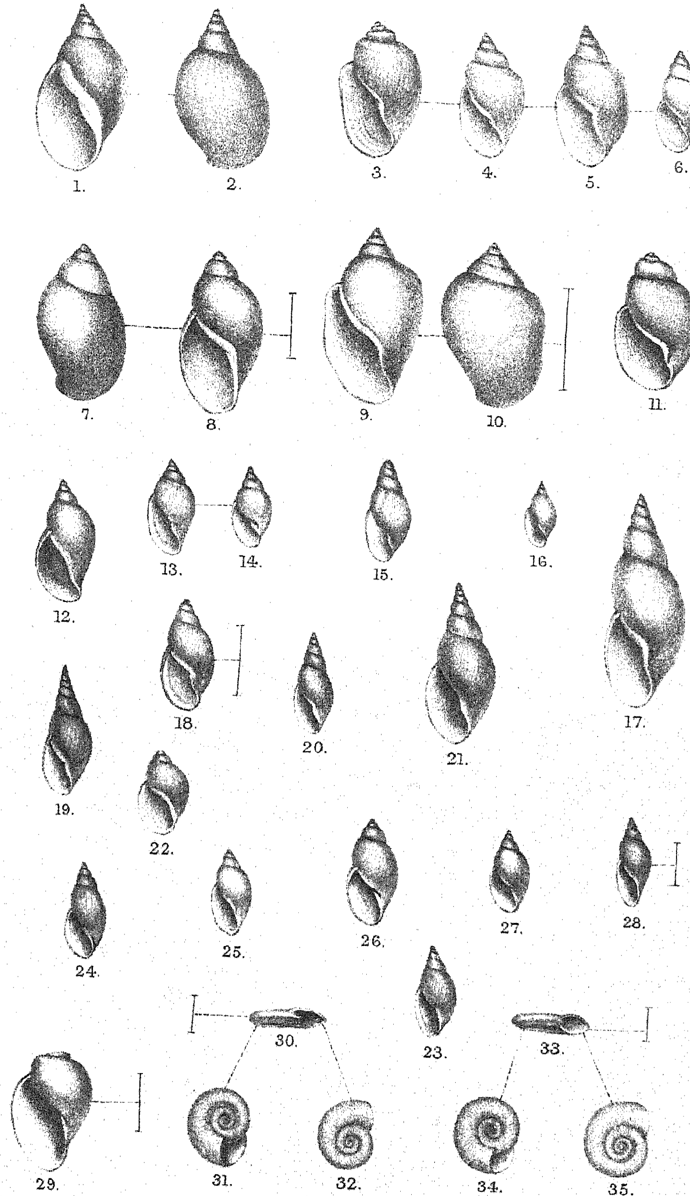
PLATE VI.

Figs. 1–2. Physa marginata.
3–6. P. gibbosa.
7–8. P. australis.
9–10. P. Ludwigii.
11. P. pectorosa.
12. P. australiana.
13–14. P. concinna.
15. P. olivacea.
16. P. acutispira.
17. P. pyramidata.
18. P. fusiformis.
19. P. Beddomei.
Figs. 20. Physa gracilenta.
21. P. producta.
22. P. Brazieri.
23. P. queenslandica.
24. P. Quoyi.
25. P. Etheridgii.
26. P. breviculmen.
27. P. tenuilirata.
28. P. exarata.
29. P. bonus-henricus.
30–32. Planorbis Gilberti.
33–35. P. essingtonensis.



C. Berjeau del et lith.   Mintern Bros. imp.

AUSTRALIAN FRESH-WATER SHELLS.



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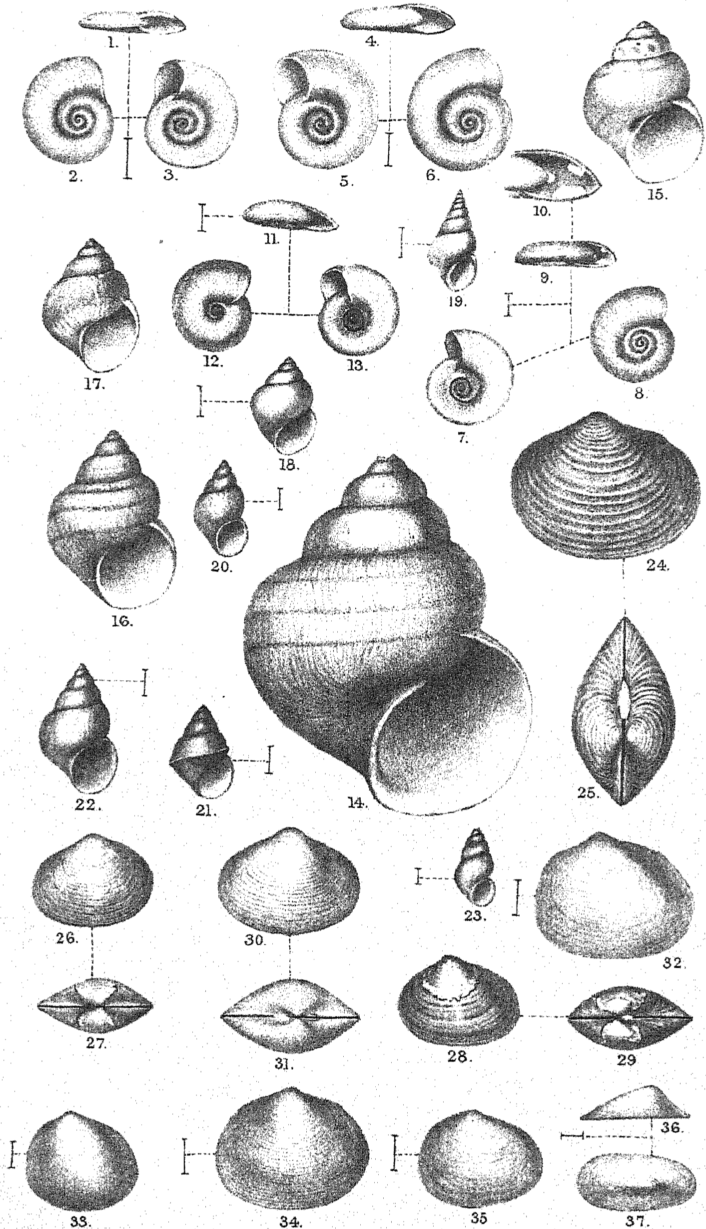
AUSTRALIAN FRESH-WATER SHELLS.



C. Berjeau del. et lith. Mintern Bros. imp.

AUSTRALIAN FRESH-WATER SHELLS.

PLATE VII.

Figs. 1–3. Planorbis fragilis.
4–6. P. macquariensis.
7–10. Segmentina australiensis.
11–13. S. victoriæ.
14. Vivipara Waterhousei.
15. V. Kingi.
16. V. tricincta.
17. V. dimidiata.
18. Bithinia australis.
19. Tatea rufilabris.
20. Hydrobia victoriæ.

Figs. 21. Hydrobia Brazieri.
22. H. Angasi.
23. H. Petterdi.
24–25. Corbicula ovalina.
26–27. C. nepeanensis.
28–29. C. Deshayesii.
30–31. C. sublævigata.
32. Sphærium translucidum.
33. S. queenslandicum.
34. S. Macgillivrayi.
35. Pisidium Etheridgii.
36–37. Ancylus australicus ?

Contributions to the Ornithology of New Guinea. By R. Bowdler Sharpe, F.L.S., F.Z.S. Part VII.—Diagnoses of new Species of Birds from the back of the Astrolabe Range, S.E. New Guinea.

[Read March 2, 1882.]

I am indebted to my friends Messrs. Osbert Salvin and F. Du Cane Godman for the opportunity of examining a very interesting collection of birds lately received by them from their correspondent Mr. A. Goldie. The name of this collector is well known in connexion with the natural history of South-eastern New Guinea; and in the present instance, having visited fresh ground, he has procured several very striking species of birds, some of which appear to be new to science. I am preparing for the Society a detailed account of the collection; and in the meantime content myself with supplying diagnoses of some species which seem to me to be undescribed.

Order PSITTACI.

Trichoglossus Goldiei, sp. n.

Supra viridis, collo postico flavo vario; pileo purpurascente; fronte et sincipite et facie laterali scarlatinus, hac purpureo lavata; remigibus rectricibusque viridibus, intus pallide flavis; corpore subtus toto viridi-flavicante, plumis late saturatiore viridi distincte striatis; abdomine imo viridiore et vix striolato; subalaribus et subcaudalibus tamen distincte viridi striatis. Long. tot. 6·5, alæ 4, caudæ 3, tarsi 0·5.

CYCLOPSITTACUS COCCINEIFRONS, sp. n.

Similis *C. diophthalmo*, sed fascia frontali, loris, genis et regione parotica sordide coccineis nec scarlatinis distinguendus. Long. tot. 5·6, alæ 3·65, tarsi 0·3.

Order PASSERIFORMES.

Fam. MUSCICAPIDÆ.

PŒCILODRYAS ALBIFACIES, sp. n.

Similis *P. leucopi*, sed regione periophthalmica tota alba distinguenda. Long. tot. 4·5, alæ 2·85, tarsi 0·8.

MONARCHA PERIOPHTHALMICUS, sp. n.

Affinis *M. fratro*, sed regione periophthalmica tota nigra distinguendus. Long. tot. 5·5, alæ 3·4, tarsi 0·75.

Fam. CAMPOPHAGIDÆ.

EDOLIISOMA POLIOPSA, sp. n.

♀. *E. schisticipiti* ♀ affinis, sed mento, genis anticis et regione parotica tota schistaceis distinguenda.

Fam. LANIIDÆ.

PACHYCEPHALOPSIS POLIOSOMA, sp. n.

Supra omnino cinerea, pileo vix obscuriore; tectricibus alarum dorso concoloribus; remigibus caudaque brunnescentioribus; loris et superciliis cum regione parotica cinerascentibus; regione anteoculari et fascia suboculari nigris; subtus cinerea; abdomine imo et subcaudalibus albicantibus; gula albicanti-brunnea, lateraliter cinereo lavata; genis albidis, fasciam indicantibus; axillaribus et subalaribus cinerascentibus; remigibus infra sepiariis, intus pallide brunneo limbatis. Long. tot. 6·3, alæ 4·2, tarsi 1·2.

Fam. MELIPHAGIDÆ.

ZOSTEROPS DELICATULA, sp. n.

Affinis *Z. frontali*, sed genis anticis cum loris et sincipite nigris, et præcipue pectore lateribusque delicate cinereo distinguenda. Long. tot. 3·8, alæ 2·3, caudæ 1·55, tarsi 0·65.

MELILESTES POLIOPTERUS, sp. n.

Affinis *M. novæ guineæ*, sed alis et pileo plumbeis et macula gutturali flava distinguendus. Long. tot. 4·4, culmen 1·2, alæ 2·05, caudæ 1·55, tarsi 0·7.

PTILOTIS MARMORATA, sp. n.

Similis *P. cinereæ*, Sclater, sed minor et plumis gutturis et præpectoris albido marginatis distinguenda. Long. tot. 7, culm. 1·05, alæ 3·8, caudæ 3·7, tarsi 1·05.

Fam. TIMELIIDÆ.

EUPETES PULCHER, sp. n.

Affinis *E. castanonoto*, Salvad., sed pileo rufescenti-brunneo nec dorso concolori, et fascia gutturali nigra gulam albam cingente absente.

Fam. FRINGILLIDÆ.

MUNIA GRANDIS, sp. n.

Similis *M. jagori*, sed multo major et pileo colloque totis cum corpore subtus toto nigerrimis, hypochondriis castaneis exceptis, distinguenda. Long. tot. 4, alæ 2·2, tarsi 0·65.

Description of a new Genus and two new Species of Insectivora from Madagascar. By OLDFIELD THOMAS, F.Z.S., Zool. Depart. British Museum. (Communicated by Dr. J. MURIE, F.L.S.)

[Read March 2, 1882.]

IN the collection of Mammalia recently brought by the Rev. W. Deans Cowan from Eastern Betsileo there occur a large number of two small shrew-like animals—one, of which there are no less than thirty-nine examples, having a most extraordinarily long tail, from two to three times the length of the head and body; and the other, represented by eight specimens, with a tail rather shorter than the trunk. These two species, at first sight so different, prove, on a closer examination, to belong to the same genus, and that a hitherto undescribed one. It belongs to the well-known Madagascar family Centetidæ. I propose to call it

MICROGALE, gen. nov.

Dentition:—I. $\frac{3}{3}$, C. $\frac{1}{1}$, P.M. $\frac{3}{3}$, M. $\frac{3}{3}\times 2=40$.

Upper incisors small, the first two slightly exceeding the third in height, each with one posterior secondary cusp, and the second one with two anterior secondary cusps of equal height, one internal and the other external. Canines very slightly larger than the first incisors, with minute anterior and posterior secondary cusps. Premolars small, the first linear, the second and third triangular, all with anterior and posterior secondary cusps. Molars triangular, somewhat like those of *Centetes* on a small scale, but each with a well-marked internal basal ledge, and along the outer side three or four variously proportioned minute cusps.

In the lower jaw the incisors are very small, the two middle ones nearly horizontal, slightly spatulate, and each with one external secondary cusp; second and third pairs, and the canines, each consisting of one large anterior and one small posterior cusp. Premolars and molars all about equal in height, and very similar in general form to those of *Centetes*; but the posterior ledge of the last molar has a well developed cusp, half the height of the main anterior one, so that externally this tooth appears to be twice the size of any of the others.

Skull with united nasals, a ring-shaped tympanic bone, and a well-marked lacrymal canal. Clavicles well-developed. Tibiæ and fibulæ anchylosed together for their distal halves.

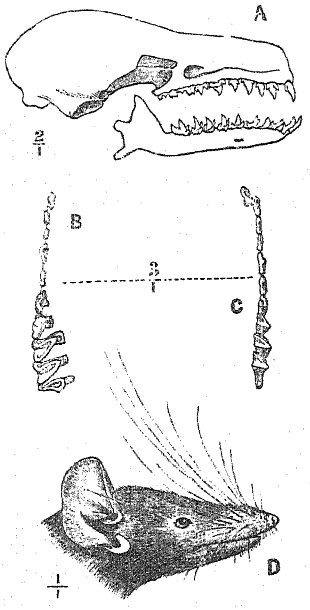
Vertebral formula—cervical 7, dorsal 16, lumbar 5, sacral 2, and caudal $\left\{\begin{array}{l}\text{44 in } \textit{M. longicaudata.}\\ \text{24 in } \textit{M. Cowani.}\end{array}\right.$

Fur soft, not spiny. Ears large. Muzzle with a naked tract from nose to upper lip. Toes 5—5, not fossorial. Tail well developed.

MICROGALE LONGICAUDATA, sp. nov. (Type of genus.)

Fur long and soft, in colour very much as in *Mus musculus*, namely dark slaty blue, the tips of the hairs above brown, below fawn. Lips and upperside of feet lighter.

Tail more than twice the length of the body and head combined (see dimensions below), covered with scales and short hairs, slate- above, pale flesh-colour below. Feet and claws small; soles nearly or quite naked, minutely granulated, with six pads on both fore and hind limbs. Ears very large, laid forward they quite cover the eyes. Naked tract from muzzle to lips with a median groove, in addition to the two faint grooves which form its boundaries.



Microgale longicaudata:—A, Side view of skull, twice nat. size. Teeth (B) of upper jaw, (C) of lower jaw, three times nat. size. D, Exterior of head in profile, about nat. size.

MICROGALE COWANI, sp. n.

Very similar to *M. longicaudata* in its cranial and dental characters; but externally, though its colour is

quite the same, it is readily distinguishable from that species by its larger size, smaller ears, very much shorter tail (see dimensions below), and its proportionally shorter feet and shorter fifth toes. The naked line on the underside of the muzzle is also narrower than in *M. longicaudata*, and has no additional median groove.

Dimensions.

	Head.	Head and body.	Tail.	Hind foot.	Forearm and hand.	Ear-conch, length.	Muzzle to ear.
M. longicaudata:							
a. Spec. figd. and described ...	in. 1·03	in. 2·65	in. 6·2	in. ·71	in. ·92	in. ·60	in. ·75
b.	·98	2·40	5·8	·70	·89	·52	·72
c.	·91	2·15	4·7	·64	·78	·55	65
d.	·92	2·05	4·6	·61	·75	·56	·62
e.	·93	2·20	4·4	·63	·77	·57	·65
f.	·98	2·27	4·45	·65	·77	·56	·68
M. Cowani:							
a. Spec. described	1·10	3·0	2·5	·64	·82	·50	·85
b.	1·05	2·65	2·15	·56	·76	·46	·78
c.	·92	2·45	1·95	·54	·68	·46	·70
d. (imm.).........	·92	2·25	1·7	·55	·72	·40	·69

Skulls.

	Length.	Breadth across brain-case.	Between maxillary zygomatic processes.	Length of upper dental series.	Lower dental series.	Length of lower jaw.
M. longicaudata.	·78	·33	·26	·36	·35	·52
M. Cowani * ...	·84	·36	·32	·40	·36	·55

All the specimens of both species were obtained by Mr. Cowan in the Ankáfana forest, Eastern Betsileo, between the middle of February and the middle of March, 1880. This time of year being, in Madagascar, the autumn, and therefore not the breeding-season, I have been unable to make out the number of mammæ, or any other characters connected with the sexual organs.

Microgale differs from *Geogale*, a genus recently described by Prof. A. Milne-Edwards †, by the quite different shape of its skull and teeth, and by the much larger number of the latter.

This genus is an extremely interesting one, as adding another connecting link between *Centetes* and *Potamogale*, agreeing with the former in the possession of a clavicle and lacrymal canal, and with the latter by its long tail, soft fur, and united tibia and fibula. I am indebted for a knowledge of the correct position of

* Anterior milk-incisors still remaining.

† Ann. Sc. Nat. 1872.

this genus to Dr. G. E. Dobson, who has had the advantage of seeing in Paris the types of *Geogale aurita*, the form to which, merely from Prof. Milne-Edwards's description, I had originally thought it most nearly allied.

With regard to the arrangement of the flexor tendons of the hind feet, on which Dr. Dobson* has recently laid much stress, it would appear that this part in *Microgale* is still in a rather early and undifferentiated condition, the two muscles in question, the *flexor hallucis longus* and the *flexor digitorum longus*, not having become fully separated, as their tendons are united in the sole of the foot, and form but one broad tendinous mass, which splits up again into five digital slips.

On a new Species of Sand-Martin (*Cotile*) from Madagascar. By R. Bowdler Sharpe, F.L.S., F.Z.S., &c., Department of Zoology, British Museum.

[Read March 2, 1882.]

The Rev. Deans Cowan has lately been exploring the Forest of Ankáfana in the Betsileo country, Madagascar, and has brought thence a very large and interesting collection in all branches of natural history. Amongst the birds there is an apparently undescribed species of *Cotile*, which I propose to call, after its discoverer,

Cotile cowani, sp. n.

Adult female. General colour above dark sooty brown, slightly paler on the lower back and rump; wing-coverts like the back, the inner greater coverts and inner secondaries rather lighter and with slightly paler margins; primary-coverts and quills very dark brown; tail-feathers very dark brown, with narrow paler edgings, the outermost feathers very narrowly fringed with white; lores blackish; ear-coverts and sides of face dark sooty brown, the cheeks and throat ashy brown; remainder of under surface of body dark ashy brown, including the thighs; lower abdomen whitish; under tail-coverts pure white; axillaries and under wing-coverts dark ashy brown like the breast, the edge of the wing with paler ashy margins to the feathers; quills dark brown

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* Monograph of the Insectivora, p. 67 &c. (1882).

below, rather more ashy along the inner web. Total length 4·8 inches, culmen 0·25, wing 3·65, tail 1·9, tarsus 0·4.

Hab. Ankáfana Forest, Betsileo, S.E. Madagascar. Native name "Firizinga."

This species comes nearest to *Cotile paludicola* of South Africa, but differs in the following particulars:—

1. The general colour above is altogether darker, and approaches more to blackish brown.

2. In the adult South-African bird the brown colour commences at the chin and spreads over the whole fore neck and breast in one uniform tint, the lower breast and entire abdomen and under tail-coverts being pure white. In the Madagascar species the general aspect of the under surface is uniform ashy brown, with a little white on the lower abdomen, and the under tail-coverts are white. The throat, however, is light ashy, contrasting with the dark colour of the rest of the under surface; and in this contrast consists the principal distinguishing character of *Cotile Cowani*.

I may add that Mr. Deans Cowan brought a large series of this new Martin, and I have carefully compared them with a series of *C. paludicola*.

The young bird differs from the adult in having rufous margins to the feathers of the upper surface, wing-coverts, and secondaries, while the throat and breast are also suffused with rufous.

There is no difference in colouring in the sexes. The male measures, total length 4·7 inches, wing 3·65, tail 1·9, tarsus 0·4.

MOLLUSCA OF H.M.S. 'CHALLENGER' EXPEDITION.—Part XII.

By the Rev. ROBERT BOOG WATSON, B.A., F.R.S.E., F.L.S.

[Published by permission of the Lords Commissioners of the Treasury.]

[Read December 15, 1881.]

Fam. CANCELLARIIDÆ.
VOLUTIDÆ.
FASCIOLARIIDÆ.
Fam. COLUMBELLIDÆ.
OLIVIDÆ.

The Volutes are the most interesting of the 'Challenger' Mollusca. In particular I may mention *Volutilithes abyssicola*, Adams and Reeve, known hitherto only in the form of a single, very young shell, got by the 'Samarang' off the Cape of Good Hope in 132 fathoms. Of this the 'Challenger' got three specimens from the same locality, presenting in their full-grown form features of so much importance as to require a complete revision of the species, especially in its relations to the Miocene forms of the genus.

Even more interesting is the new Volute form of *Provocator* from Kerguelen Island, 105 fms., presenting the apex of an *Ancillaria*, the suture of a *Bullia*, the pillar-plaits of a *Voluta*, and the lip-sinus of a *Pleurotoma*.

The gem of the whole collection, however, is the very remarkable and beautiful *Wyvillea alabastrina*, from 1600 fms., or nearly 10,000 feet, in the Antarctic Sea, which very much exceeds in size any thing yet obtained from the great ocean-depths. The specimen having been secured in life, Professor Huxley has undertaken the minute dissection and description of the animal, which was preserved in spirit.

There are many other forms of interest embraced in this part of my Report which I need not enumerate here. I may add, however, in this place that the exigencies of the official Report and the embarrassments of my own professional work compel me to deal more summarily with the material entrusted to me than I have hitherto thought it right to do. This will explain the omission of many groups which, embracing only very small or badly preserved specimens, require a greater amount of minute study than time allows me now to give. These may possibly be overtaken afterwards, but must be neglected now.

Fam. CANCELLARIIDÆ, *Adams*.

CANCELLARIA, *Lam.*

1. *Cancellaria imbricata*, n. sp.
2. *C.* (*Admete*) *specularis*, n. sp.
3. *Cancellaria* (*Admete*) *carinata*, n. sp.

1. CANCELLARIA IMBRICATA, n. sp.

St. 142. Dec. 18, 1873. Lat. 35° 4′ S., long. 18° 37′ E. Off Cape of Good Hope. 150 fms. Sand. Bottom temperature 47°.

Shell.—Oval, with a smallish, high, subscalar, blunt spire, a semicircular mouth, and a rough spirally striated surface; yellowish white. *Sculpture.* Longitudinals—on the upper whorls there are some slight rather distant ribs, which pass over on the later whorls into rough imbricated adpressed laminæ covering the whole surface. Spirals—there are flatly rounded threads parted by intervals of twice their breadth; below the suture 2 are feeble, 4 in the middle are strong, 5 on the base are narrow and sparse, and 5 to 6 on the snout are slight and close: besides these, there are minute spirals and lines of growth which reticulate crisply the whole surface. *Colour* porcellaneous white beneath a yellowish surface, which is quite stripped of epidermis. *Spire* high, rather small, conical, subscalar. *Apex* blunt and globose, consisting of 1¾ rounded embryonic whorls, of which the extreme tip is very much depressed on one side. *Whorls* 5 in all, well rounded, the earlier small and of slow increase, the last large, with a short base and a small snout. *Suture* impressed. *Mouth* rather large, semicircular. *Outer lip* regularly rounded and open, strongly seamed within by the spirals of the surface. *Inner lip*: a very thin glaze spreads broadly over the body, but narrows and thickens on the small hollowed and twisted pillar, leaving a very minute chink in front; there are below the middle of the pillar two strongish, very oblique white teeth; and the twisted edge of the pillar is prominent and sharp. H. 0·8. B. 0·5. Penultimate whorl, height 0·16. Mouth, height 0·46, breadth 0·3.

The specimen of this species is perhaps not quite full-grown. The whole aspect of the shell suggests an *Admete*; but the teeth on the pillar are stronger than is usual in that group. It is much shorter in the spire, broader in the whorls, and more delicately sculptured than *C. turrita*, Sow.

2. CANCELLARIA (ADMETE) SPECULARIS, n. sp.

St. 149 b. Jan. 17, 1874. Lat. 49° 28′ S., long. 70° 30′ E. Near entrance of Royal Sound, Kerguelen. 30 fms. Mud.

St. 151. Feb. 7, 1874. Lat. 52° 59′ 30″ S., long. 73° 83′ 30″ E. Off Heard Island. 75 fms. Mud.

Shell.—Small, ovate, striated, with a shortish, scalar, blunt-tipped apex, a rounded base, very small snout, and semicircular mouth. *Sculpture.* Longitudinals—there are strongish numerous hair-like lines of growth. Spirals—below the suture is a shoulder marked by an angulation carrying a thread; the shoulder is indistinctly scored with spiral threads: from the angulation to the snout there are several well-marked threads parted by shallow broader furrows; toward the point of the snout is a twisted scar. The whole surface is scored by fine, almost microscopic lines. *Colour* porcellaneous white under the thin dirtyish yellow epidermis. *Spire* rather short and broad, conical, scalar. *Apex* blunt, round, a little bent in at the tip. *Whorls* 5½, rounded, slightly angulated near the top, with a slight shoulder above the angle, of rather regular increase; the last has a somewhat produced base and a very small snout. *Suture* impressed. *Mouth* rather large, semicircular. *Outer lip* regularly rounded and open; seamed within by the spirals of the surface. *Inner lip* well defined, narrow, having a talc-like iridescence*, very straight on the pillar, on the front of which the glaze turns sharply over to the inner side, and leaves there a very slight chink in front: at the point of the pillar the edge is twisted and is bluntly prominent, and above this are one or two faint folds. H. 0·45. B. 0·27. Penultimate whorl, height 0·1. Mouth, height 0·22, breadth 0·16.

In form this species resembles *A. viridula*, Fabr., = *Couthouyi*, Jay, of the British Museum; but that species has not the talc-like inner lip, is not so well shouldered, nor is the shoulder defined by a spiral thread, and the spirals in general are much stronger; the body-whorl is larger, more tumid, and more contracted on the base. Dr. Kobelt very kindly copied out and sent me the diagnoses of two species of *Cancellaria* from the Straits of Magellan, with which he thought I might wish to compare this of the 'Challenger.' These are *C.* (*Admete*) *australis*, Philippi, and *C.* (*A.*) *Schythei*, Phil. I have not, I think, seen either of these; but they both seem to be very much more strongly ribbed and spiralled than the present or following species. One of the specimens from Kerguelen contains the animal; but I failed to extract it, and only ascertained that there was no operculum.

* From this feature I have derived the name of the species.

In this specimen the folds on the pillar-lip are more distinct than on the Heard-Island specimen.

There is an *Admete* from St. 149 c, Kerguelen, Royal Sound, 60 fms., which is too much broken for identification, but which is probably this species.

3. CANCELLARIA (ADMETE) CARINATA, n. sp.

St. 149 d. Jan. 20, 1874. Lat. 49° 28′ S., long. 70° 13′ E. Royal Sound, Kerguelen. 28 fms. Mud.

Shell.—Broadly ovate, carinate, spiralled, with a very short, blunt, scalar spire. *Sculpture.* Longitudinals—there are only fine, sharp, unequal puckerings on the lines of growth. Spirals—a sharp flanged keel lies about the middle of the whorls; above this is the horizontal, slightly concave shoulder, on which are no spirals; below the keel the whole surface is scored with fine prominent rounded unequal threads, parted by broader intervals; those on the snout are feeble. *Colour* white. *Spire* very short and depressed, but rising in broad shallow steps. *Apex* small, raised. *Whorls* 5, flattened or even slightly concave above, strongly keeled and angulated in the middle, of regular increase; the last is very large and ventricose, with an elongated but convex base and a very small snout. *Suture* impressed, very horizontal. *Mouth* fully half the size of the shell, oval, angulated at the keel and at the base of the pillar. *Outer lip* rounded and open, advancing a little in front of the point of the pillar. *Inner lip* thinly spread on the body, with a small chink in front behind the pillar, the edge of which is narrow and twisted, with two indistinct folds above it. H. 0·4. B. 0·28. Penultimate whorl, height 0·07. Mouth, height 0·3, breadth 0·17.

I failed to extract the animal from the shell; but plainly it had no operculum. The extreme bluntness and tabulation of the spire give a very peculiar aspect to this species.

Fam. VOLUTIDÆ, *Gray*.

Gen. VOLUTILITHES, *Swains.*

VOLUTILITHES ABYSSICOLA, *Ad. & Reeve.*

Adams & Reeve, Zool. Samarang, Moll. p. 25, pl. vii. fig. 6 (*Voluta*); Adams, Genera, I. p. 167, II. p. 618, III. pl. xvii. fig. 8; Chenu, Man. f. 980; Reeve, C. I. 1849, pl. xxii. fig. 58; Fischer, Journ. de Conch. 1871, p. 305; v. Martens, Jahrbücher d. malak. Gesell. 1874, p. 140; Kobelt, Jahr. d. malak. Gesell. 1877, p. 312.

St. 141. Dec. 17, 1873. Lat. 34° 41′ S., long. 18° 36′ E. 25 miles S.S.E. from Cape of Good Hope. 98 fms. Sand and gravel. Bottom temperature 49°·5 F.

St. 142. Dec. 18, 1873. Lat. 35° 4′ S., long. 18° 37′ E. 45 miles S.S.E. from Cape of Good Hope. 150 fms. Sand. Bottom temperature 47° F.

Shell.—Fusiform, thin, with a rather high subscalar spire, a small rounded apex, a very long base, a slightly thickened, reverted, and toothed outer lip, a long narrowish mouth, a twisted many-toothed pillar, and an expanded inner lip. *Sculpture.* Longitudinals—there are on the last whorl about 70 riblets or flatly rounded threads following the lines of growth, which last roughly and closely score the whole surface. Spirals—there are from 30 to 40 rather higher and broader threads covering the whole surface; those below the suture are slightly stronger than the others; the first in particular is so, and is followed by a deeper furrow; all these in crossing the longitudinals tend to rise into small tubercles: below the suture is a very small flattened shoulder with an outward droop; this on the upper whorls is slightly excavated. The whole surface is fretted with fine microscopic scratches. *Colour* pale ashy brown, glossy. *Spire* subscalar, high, its height being to its breadth in the proportion of 13 to 6. *Apex* small, eroded. *Whorls* 8, flatly convex, very slightly shouldered below the suture. *Suture* very oblique and strongly marked. *Mouth* very small for the genus, long and narrow, with a small open canal in front. *Outer lip* very slightly sinuated and ascending above, narrowly reversed, and a little thickened, with many close-set, equal, short, narrow teeth; at the point it is very slightly sinuated and patulous, but not reversed. *Inner lip* spreads in a broad thin glaze across the body; it is slightly oblique, hardly concave, a little twisted and bent back in front, with (about the middle) 8 to 10 larger or smaller teeth somewhat irregularly distributed. H. 3·8. B. 1·5. Penultimate whorl, height 0·6. Mouth, height 2·6, breadth 0·75.

This interesting species has hitherto been known only in the solitary type specimen obtained by Sir E. Belcher in H.M.S. 'Samarang,' 1843, off the Cape at a depth of 132 fms., and described by A. Adams and L. Reeve in the Mollusca of the Expedition. That specimen being a very young shell, a redescription from the specimens of the 'Challenger' was necessary. Of these there are three—one, the largest, described above; the second

with $6\frac{3}{4}$ whorls, but with a fully developed outer lip, itself an aftergrowth on an earlier lip-edge still existing within the mouth; the third has 6 whorls, but has the sharp thin edge and undeveloped pillar-teeth of the 'Samarang' specimen. The later development of the shell greatly detracts from the "sharply defined pattern of lattice-work," the sculpture becoming much less crisp, the elongation and contraction of the body-whorl diminishes the relative breadth, the increasing obliquity of the whorls elevates the spire, and the subsutural canal ceases to be excavated and becomes merely a small oblique shelf. All these changes modify considerably the relations of this Volute to the Eocene species referred to by Adams and Reeve, and also by Mr. Edwards in his 'Eocene Mollusca' (Palæont. Soc.), pp. 146, 155, and in particular to *V. crenulata*, Lam. (see Edwards, p. 154, pl. xx. f. i.); but while diminishing some features of distinction dwelt on by these authors, they so strongly develop others, that the difference between the living and the fossil species stands out more strongly than ever. The size and form are, indeed, so utterly dissimilar, as at once to constitute a marked distinction. At the same time, the species does interestingly represent the older forms, in shape and sculpture recalling *V. digitalina*, Lam., *V. crenulata*, Lam., and *V. elevata*, Sow., perhaps in particular; the thickening and toothing of the outer lip resembles exactly that of *V. luctatrix*, Solander, and *V. ambigua*, Sol., while the toothing of the pillar is like that of *V. nodosa*, Sow. Of course whatever generic value "*Volutilithes*" of Swainson may have, Adams's definition of the genus as having a "columella with numerous faint rudimentary or obsolete plaits; outer lip thin, simple," must be modified. It never suited more than one or two of the fossil species, perhaps not even these; it proves inaccurate for the one living representative of the group except in its immature state.

Provocator, n. gen.

Shell smooth, fusiform; having the apex of *Ancillaria*, the enamelled suture of *Bullia*, the pillar-folds of *Voluta*, and the sinus of *Pleurotoma*.

I believe this very curious form to be essentially a Volute, in which genus the group of *Cymbium*, and forms like *V. scapha*, Gmel., *V. imperialis*, Lam., and many others present the sutural sinus, while *Zidona* has the enamelled spire. The name of *Challen-*

geria being preoccupied, I have been obliged to reproduce it as I could in Latin.

PROVOCATOR PULCHER, n. sp.

St. 149 j. Jan. 29, 1874. Lat. 48° 43′ S., long. 69° 15′ E. West Christmas Harbour, Kerguelen. 105 fms. Mud.

St. 150. Feb. 2, 1874. Lat. 52° 4′ S., long. 71° 22′ E. Between Kerguelen and Heard Island. 150 fms. Rock. Bottom temperature 35°·2 F.

Shell.—Smooth, fusiform, rather thin, with a high, sharp, slightly enamelled apex, a contracted and elongated base, a straight two-toothed pillar, a large mouth, a prominent angulated and patulous outer lip, and a strongly marked sinus at the enamelled suture. *Sculpture.* Longitudinals—the smooth surface is scored with fine hair-like flexuous lines of growth. Spirals—there are some lines in the substance of the shell which are best recognized without a lens: there are also some irregular white lines connected with some slight thickening of the glaze; below the scar of the sutural sinus is an obsolete angulation. Besides all this, the surface of the enamel of the shell is obsoletely tubercled obliquely. *Colour* rich buff, thinly overlaid with a whitish glaze; this for some distance below the suture is covered with a dullish buff enamel. *Spire* high, conical, subscalar. *Apex* small and sharp, being originally mamillated, but subsequently eroded and enamelled. *Whorls* 7 to 8, at the top very slightly shouldered and angulated, then flatly convex. *Suture* oblique, completely buried in a thick coat of glaze which fills the sutural angle, and which embraces the whole apex. *Mouth* large, pear-shaped, with a shallow, broad, obliquely truncated canal in front. *Outer lip* thin and rounded on the edge; it is cut off from the body by a strongly marked sinus, below which it advances prominently into a rounded angle, retreating slightly, but steadily, from this point throughout its whole course; it is straight and slightly contracted above, roundly angulated and patulous below the middle, straight and patulous and cut off backwards from this point to the edge of the canal. *Inner lip* scarcely convex above, little concave in the middle, direct with a very slight twist and no swelling below; near the edge are two narrow, slight, white, very oblique teeth, of which the upper is sometimes absent: the narrow sharp lamina of the pillar-edge in front is the extreme point of the shell. H. 3·6. B. 1·8. Penultimate whorl, height 0·8. Mouth, height 2, breadth 0·95.

This is an extremely peculiar form of great beauty. It is higher and narrower than the measurements would suggest, the outthrow of the outer lip being great, but of short continuance. It has a strong general resemblance to *Ancillaria glabrata*, L., or *A. Vernedei*, Sow., or other smaller species of that form, of which it simulates the subperipheral band. In *Voluta pallida*, Gray, some of the peculiar features of this species—such as the sutural sinus, the enamelled spire, and the outthrow of the outer lip at its lower corner—are found, though in a much feebler form.

The swelling on the pillar which is characteristic of the Volutes, and is really the scar of the old columellar sinus, is in this species quite absent in front, but is just recognizable on the back of the shell in the flexure of the lines of growth.

Cymbiola, *Swains.*

Cymbiola lutea, n. sp.

St. 166. June 23, 1874. Lat. 38° 52′ S., long. 169° 20′ E. About 200 miles west of Cape Farewell, New Zealand. 275 fms. *Globigerina*-ooze. Bottom temperature 50°·8.

Shell. Fusiform, strongish, pale buff, with a high blunt spire, largish mouth, slightly reverted outer lip, and four teeth on the pillar. *Sculpture.* Longitudinals—On the upper whorls there are a few slight narrow ribs, which are almost obsolete on the later whorls; the lines of growth are many and hair-like. Spirals quite obsolete. The columellar swelling in front is very small and slight. *Colour* ashy white over pale buff, entirely without gloss; the outer lip and the body-glaze are rich buff, paler inwards. *Spire* high, a little irregularly bent, subscalar. *Apex* blunt, mamillary, impressed. *Whorls* $6\frac{3}{4}$: they are convex, above contracted into the suture, perpendicular below; after the first three they increase rapidly; the last is slightly ventricose, long, attenuated in front. *Suture* oblique, slightly impressed, irregular. *Mouth* long, but not wide, oblique, with its two sides nearly parallel, bluntly pointed above, ending below in a broad, shallow, slightly emarginated, minutely bordered canal. *Outer lip* patulous, thin, but expanded and rounded on the edge; it rises on the penultimate whorl at its junction, and is here drawn back into a slight sinus with a very reverted edge. *Inner lip* spreads widely as a thin glaze on the body; above it is scarcely convex, hardly concave in the middle, perpendicular below, where are four, not strong, equal, concealed, pale-coloured, very oblique teeth;

obliquely cut off, twisted and rounded in front into a prominent thin point. H. 2·75. B. 1·25. Penultimate whorl, height 0·53. Mouth, height 1·73, breadth 0·6.

This species is suggestive of many others, and may be compared with *Voluta rupestris*, Gm., *V. pacifica*, Sol., *V. lyriformis*, Vigors, and *V. fulminata*, Lam.; but resembles most *V. megaspira*, Sow., having the same long thickened lip and form of body-whorl, but in that species the spire is higher and is fine.

Wyvillea, n. gen.

Animal a typical *Volute.*

Shell ovate, cymbiform, thin, rough; spire high scalar; apex mamillate and irregular; suture canaliculate; mouth large, ovate; inner lip with a widespread thinnish callus; pillar perpendicular, with a very slight turn; it has no teeth, but an abrupt break of the edge about the middle of its length.

This genus differs from *Cymbiola* of Swainson (the description of which by Adams I have nearly followed) notably in the texture of the shell, which is extremely delicate but rough on the surface, in the suture, which is canaliculate, and in the straight pillar, which is without teeth, but has an abrupt break on the edge. In all the Volutes the last tooth consists of a lamina attached to, or consisting of, the edge of the pillar, the twist on which throws this lamina out as an oblique fold whose abrupt slope looks up the pillar. In *Wyvillea*, on the other hand, the lamina has scarcely a turn at all, and only presents a tooth in consequence of being suddenly arrested and diminished in size; from this results a tooth whose abrupt slope looks down the pillar.

In connexion with this genus it may be well to recall the *Halia* of Risso, which has some vague features of superficial resemblance; but in that genus the columellar tooth, which is almost terminal, results from the extreme and sudden twisting of the pillar.

I have not given a detailed description of the animal, as Prof. Huxley has undertaken the dissection and full representation of it in all its parts.

Wyvillea alabastrina, n. sp.

St. 147. Dec. 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E. Off Marion Island and the Crozets. Bottom temperature 34°·2. *Globigerina*-ooze. 1600 fms.

Animal has an enormous bifid foot, square in front, pointed

and high behind; compared to this part the head, mantle, and body are small; the snout is largish and subcylindrical, above it the great velum extends widely, and is collected into a subconical protuberance at the corners, from which rise the rounded conical tentacles; no trace of eyes exists. Above the head is the mantle, expanded on the left into the rather short, stumpy, and proboscis-like siphon, which is open below. The reproductive organs, possibly to some extent everted at death, appear like a large tumour on the neck, a considerable way behind the right tentacle. The skin is not tubercled. There is no operculum.

Shell.—Large, high, thin, white, alabaster-like in texture, with an oval body, a smallish high scalar spire, ending in an irregular, blunt but pointed, twisted apex; it has a large oval mouth, a narrow, patulous, not reverted, outer lip, a broad, shallow, truncated canal in front, a broadly spread inner lip, and a straight, toothless, but interrupted pillar. *Sculpture.* The whole surface is minutely granulated, and has the appearance of having been dipped in thin, rather sandy whitewash, and then roughly wiped, especially round the suture. Longitudinals—there are rounded irregular lines of growth, which are generally slight, but all round the mouth-edge a few become somewhat strong. Spirals—there are a few unequal and irregular, broad, scarcely raised threads; near the suture are a few irregular, sharper, quite superficial lines like the marks of rough wiping. *Colour* alabaster-white, with a roughened, dead, eroded surface. *Spire* high, rather small, scalar. *Apex* is blunt, but projects sharply to one side in an excentric and irregular manner. *Whorls* 5¼, of rapid increase, droopingly shouldered above, then convex, perpendicular below, with a slight tendency to contraction above the suture; the last especially is ventricose and oval, with very regular curves. *Suture* very oblique, deeply impressed, and a little canaliculate. *Mouth* oval, straight, rounded above, and not at all sinuated; it ends below in a broad, open, shallow, scarcely emarginated canal. *Outer lip* very regularly curved, with a narrow straight edge, which is prominent and patulous, but not in the least reverted; it does not rise at all on the body-whorl. *Inner lip* spreads on the body very widely, but somewhat thinly, as a straw-coloured glaze; above it is very oblique, but scarcely convex; it forms an angle at its junction with the pillar, which is perpendicular and scarcely twisted; the rounded edge is formed by a narrowish thickened white callus, which about halfway down is suddenly contracted and

slightly turned round so as to form a kind of tooth or projecting corner, below which the whole edge is smaller. H. 6·6. B. 3·15. Penultimate whorl, height 1·3. Mouth, height 4·1, breadth 2.

Bowdich's figure ('Conchology,' pt. 1. p. 68, pl. xviii. f. 2) of *Voluta* (*Cymbium*) *æthiopica*, Linn., is the best representation I know of the animal of *Voluta*, and might almost be taken to represent the 'Challenger' species. It is copied by Gray in Moll. Anim. I. xxvii. 4. Of all the mollusks got by the Expedition, this is certainly the most valuable. It is large; the shell is singularly beautiful in form and colour; it comes from a great depth and an unknown sea; and its generic features are very peculiar. It is unfortunate that it is somewhat broken. In the act of its capture, or in the extraction of the animal, the shell must have been slightly crushed, and the fragments lost. To me it came most carefully packed in cotton-wadding; but one or two small pieces of shell were found loose in the box, and these I could replace. Under my care, however, in spite of the most extreme solicitude, it met with sore disaster, probably in landing from the continent, when the sailors handle luggage more roughly than even at Suez in days of old. The breaking was so bad that the shell looked like a wreck; the bits, however, were got into their places and fixed with cement, and some professional restorer may finish the work more delicately than I could do it. In any case this unique treasure is not lost.

Volutomitra, *Gray*.

Volutomitra fragillima, n. sp.

St. 149 d. Jan. 20, 1874. Lat. 49° 28′ S., long. 70° 13 E. Royal Sound, Kerguelen. 28 fms. Mud.

Shell.—Ovate-ventricose, thin, smooth, with a short spire, a long base, a large oblong mouth, and 4 teeth on the pillar. *Sculpture*. Longitudinals—there are many fine hair-like lines of growth. Spirals—there are very many broadish, but obsolete, rounded threads; the front of the snout is obliquely crossed by about 15 stronger and more regular threads. *Colour* subpellucid white under a very thin yellowish smooth epidermis. *Spire* short and broad. *Apex* bluntly mamillate, not elevated, but rising a little on one side. *Whorls* nearly 6, convex, rounded above, sloping below. *Suture* a little impressed and strongly marked. *Mouth* oblong, somewhat oblique, rather large, pointed above, prolonged into a longish, open, truncated, but not emarginated canal. *Outer*

lip thin, sharp, regularly curved, quite straight above, where it is slightly and widely hollowed back on the edge, prominent and patulous below, a little pinched in at the canal. *Inner lip* scarcely convex above, and very little concave at the base of the pillar, which is somewhat oblique and direct; there are four oblique, rather strong teeth, of which the two in the middle are the strongest; a very thin, narrow, definite-edged glaze extends down the edge of the mouth. H. 0·57. B. 0·3. Penultimate whorl, height 0·1. Mouth, height 0·39, breadth 0·12.

Without the animal it is, of course, not easy to distinguish between this form and *Admete*, but the apex is larger and the pillar-teeth stronger than they are in that genus. The generic features are well marked in this species, which, however, resembles no other known to me.

Fam. FASCIOLARIIDÆ, *Adams*.

FASCIOLARIA, *Lam*.

1. *F. rutila*, n. sp. | 2. *F. maderensis*, n. sp.

FASCIOLARIA RUTILA, n. sp.

St. 142. Dec. 18, 1873. Lat. 35° 4′ S., long. 18° 37′ E. Off the Cape of Good Hope. 150 fms. Sand. Bottom temperature 47° F.

Shell.—Long, narrow, fusiform, not ribbed, finely spiralled, with a high, narrow spire of rounded whorls, a blunt mamillary apex, a contracted rounded base, prolonged into a long, lop-sided, slightly reversed snout. *Sculpture*. Longitudinals—there are none but small, rude lines of growth. Spirals—there are very many small, rounded, pretty equal threads parted by shallow rounded furrows of about their own breadth; on the snout these threads are feebler, sharper, and more remote. *Colour* white under a thin, brown, smooth, persistent epidermis; the inside of the mouth is tinged with buff, which is deeper on the inner lip than elsewhere. *Spire* very high, narrow, conical, but a little bent. *Apex* consists of 1 to 2, large, mamillary, but cylindrical whorls. *Whorls* 8 in all, high, narrow, of rapid increase, convex, rounded, contracted below as well as above, where they slightly lap up on the preceding whorl; the last whorl is larger than all the rest, is slightly tumid, rounded on the base, which is contracted, especially on the left, and is produced into a very long, narrow, lop-sided bent, and slightly reversed snout. *Suture* deep, but very open.

Mouth oval, direct, pointed above, prolonged into a long, oblique, narrow, open, twisted canal, which is a good deal reverted in front. *Outer lip* narrow, blunt, very finely crenulated on the edge; it is very regularly arched, and not at all patulous till it approaches the canal, where it is increasingly patulous to the point; in this part of its course its curve is concave. *Inner lip*—there is a diffuse white callus above; its whole curve is concave to the edge of the canal, where it is obliquely truncate, sharp, and twisted; its edge in front is extremely narrow and sharp; there are two slight, oblique, white teeth close to the pillar-edge. *Operculum* oval, with a pointed, almost claw-like apex; it is thinnish, horny, sharp-edged, strongly marked with lines of growth on its outer face, and having on its inner face a broad, flat, glossy swelling along its outer margin. H. 4 in. B. 1·44. Penultimate whorl, height 0·7. Mouth, height 2·2, breadth 0·78.

This is an exceptional form, having the apex of a *Fusus* (a feature shared by *Fas. coronata*, Lam.), and having a long, thin, bent canal and no longitudinal ribs or tubercles,—features which, though present in some species (as, for instance, *Fas. tulipa*, L., and *F. papillosa*, Sow.), are uncommon, especially united. It is also peculiar from the slimness of its form and the thinness of its shell. It is not a *Turbinella*, for its pillar-teeth are only two, are slight and very oblique; the operculum, too, is small and thin. No Volute has so high a spire, so small a mouth, so long and narrow a canal, nor an operculum of the form which this presents (see Journ. de Conch. 1877, p. 97).

FASCIOLARIA MADERENSIS, n. sp.

St. VII. p. Feb. 10, 1873. Lat. 28° 35′ N., long. 16° 5′ W. Off Teneriffe. 78 fms. Coral.

Shell.—Biconical, fusiform; as the shell lies on its mouth, the periphery in the centre of the back is exactly in the middle of the shell's length; solid, angulated, rough and opaque; ribbed and spirally ridged, with an umbilical chink. Mouth angularly pear-shaped, with a long, narrow, slightly oblique canal; toothed on the pillar and within the outer lip. Epidermis strong and horny. Operculum dark brown and claw-shaped. *Sculpture.* Longitudinals—there are 8 to 10 broad, low, rounded, irregular ribs; they diminish in number up the spire; they scarcely appear above the suture or on the base; the lines of growth are numerous, unequal, sharpish, but rather coarse. Spirals—there are spiral

ridges which, in crossing the ribs, rise into narrow blunt prickles, which are vaulted but scarcely open in front; of these ridges there is one on the upper whorls, three on the body-whorl, each accompanied below by its shadow, which is sometimes double; of these the highest and strongest is remote from the suture, and forms a marked shoulder; on the snout are two strongish threads, and towards its point four or five much smaller ones. The whole surface is covered with feeble microscopic striæ. *Colour* a rich buff below a darker epidermis, which is strong, horny, and persistent. *Spire* high, scalar, conical. *Apex* small and prominent. *Whorls* 9 to 10, angular, with a long, sloping, slightly concave shoulder defined by the prominent and sharp keel, below which the whorls contract a little to the inferior suture; the body-whorl is short, and contracts into a long, conical, straight, narrow snout. *Suture* slight, irregular, impressed, oblique. *Mouth* bluish white, with a narrow dirty yellowish edge; small, deep, oval, angulated above and at the keel, with a long, narrow, deep, slightly oblique canal in front; exclusive of the canal, the mouth is nearly one third of the whole length of the shell. *Outer lip*—sharp and wrinkled on the edge, patulous, with many small, close-set, deep-stretching, ridge-like teeth within; it is straight above, angulated at the keel, convex in the middle, concave as it approaches the canal, along which it is straight. *Inner lip*—a thick patulous glaze with a sharp and prominent edge, behind which is a long narrow umbilical chink; close to the upper angle of the mouth is a long feeble tooth, and in the front of the mouth and deep within are three very slight pillar-folds; the beginning of the canal is defined by a sharp little tubercle, answering to which is the lowest of the outer lip-teeth. *Operculum* thick, horny, dark brown, claw-like, with curved lines of growth; on its inner face are many concentric fine lines, with a broad, thick, rounded, polished, exterior border. H. 1·7. B. 0·95. Penultimate whorl, height 0·3. Mouth, height 1, breadth 0·5.

This species is not at all uncommon in museums under the name of *F.* (or *Turbinella*) *carinifera*, Lam., and is the species figured by Reeve as that of Lamarck, which is from the Pacific, and, though similar, is certainly different. In spite of the absence from the Geneva Museum of Lamarck's own specimens, of which (*teste* his own entry on the margin of his copy of the 'Animaux s. Vert.,' 1st edition, VII. 108, sp. 16, preserved at Geneva) he had three, and in spite of his omitting to mention the strong *basal*

carina of *T. carinifera*, I am persuaded that Lamarck had before him the Pacific species. That species differs from *F. maderensis* in being ruddy inside and outside; it lacks the two little teeth on outer and inner lip at the origin of the canal; the junction of snout and base is much more strangulated; there is a much stronger basal carina; the mouth is more open, the outer lip being much more patulous; the snout is not so regularly attenuated; the longitudinal ribs are more numerous and rise more roundly, not being flattened horizontally and pointed; the shoulder below the suture is less drooping, and the outer lip joins the body at the third, not at the second carinal spiral, thus leaving two, not merely one, spiral threads on the earlier whorls.

F. lignaria, L., a Mediterranean species, is a much narrower form, of stouter build, broader in the snout, and quite differently ribbed and spiralled. I should have liked to compare this Atlantic species with *Turbinella recuvirostra*, Wagner. The differences are obvious enough on the surface; but I do not know the species well enough to judge how far these are constant. I have with much hesitation described this as a new species, thinking so well known a form must have been already published; but, after much inquiry, I have quite failed to identify it. My reason for calling it *maderensis* is that I have long had it from Madeira, and I am not quite sure whether my *Chascax maderensis* is not a very aberrant variety. The enormous umbilicus of that species is certainly very striking; and the total absence of teeth, not only on the outer lip, but even on the pillar, is a further notable feature of difference —a feature so notable that I think my friend Dr. Kobelt, had the shell itself been before him, would hardly have suppressed *Chascax* as a mere *Fasciolaria*. Still, withal, while protesting against hasty judgment, I feel it is possible that *Chascax maderensis* and the present form may ultimately prove to be one species; and in that case it will be an advantage that they have the same specific name.

Fam. COLUMBELLIDÆ, *Ad.*

COLUMBELLA, *Lam.*

1. *C.* (*Pyrene*) *strix*, n. sp.	2. *C.* (*Pyrene*) *stricta*, n. sp.

COLUMBELLA (PYRENE) STRIX, n. sp. (*Strix*, a chamfre.)

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. North of Culebra Island, St. Thomas, Danish West Indies. 390 fms. Coral-mud.

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Var. SUBACTA. St. 23. March 15, 1873. Lat. 18° 24′ N., long. 63° 28′ W. Sombrero Island, St. Thomas, Danish West Indies. 450 fms. *Globigerina*-ooze.

St. 24. As above.

Shell.—Rather small, short, and dumpy, with a high blunt spire, a small last whorl, a very contracted base, from which projects a small, slightly reverted snout; the whorls are longitudinally chamfred and have a small beaded thread round the top. *Sculpture.* Longitudinals—there are on each whorl about 13, straight, narrow, ridge-like, but low riblets, separated by shallow furrows of two to three times their breadth; these ribs and furrows run pretty continuously down the spire, with a slight sinistral twist; toward the mouth and on the base they become feeble, but are faintly traceable on the snout. The whole surface is finely scored with lines of growth. Spirals—the suture is inferiorly margined by a slight thread, which rises into small beads in crossing the riblets; in the longitudinal furrows a faint tendency to spiral scratches is visible, which on the base arrange themselves into narrow and very superficial furrows with broadish flat threads between; these become strongish and narrower on the base of the snout, but feebler again towards its front. *Colour* glossy porcellaneous white. *Spire* rather high, narrow and conical. *Apex* a small round dome of two glossy embryonic whorls, of which the extreme tip is both immersed and flattened down with scarcely any suture. *Whorls* 8 in all, conical, with straight sides, short and broad; at the top each projects very shortly and horizontally; the last is small, with a rapidly contracted base, from which projects the small slightly reverted snout. *Suture* a very little impressed, but strongly marked by the projection of the whorl below it. *Mouth* small, rather rhomboidal, pointed above, and produced below into a short open squarish canal. *Outer lip* very straight to the corner of the base, from which it is patulous and curved; in the middle one small round tubercle projects; a little way below the suture the edge is drawn back, so as to form a very slight open false sinus. *Inner lip*: there is a thin glaze on the body, the line across which is very straight, as is also the line down the pillar, where the glaze (without teeth) forms a thickish prominent border; this border is early cut off on

the sharp oblique twisted edge of the pillar in front; the pillar is short and straight, with a slightly bent-over point. H. 0·4. B. 0·15. Penultimate whorl, height 0·08. Mouth, height 0·13, breadth 0·07.

The variety *subacta* has less developed and less regular ribs, is a little longer and smaller, and has a very slightly larger apex.

This species is closely connected with the group represented on our coasts by *C. costulata*, Cant., and of which Binney, in his edition of Gould's Moll. of Massachusetts, gives several species. It is, however, very markedly different from all of these.

COLUMBELLA (PYRENE) STRICTA, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. North of Culebra Island, St. Thomas, Danish West Indies. 390 fms. Coral-mud.

Shell.—Small, short, and dumpy, with a rather high, scalar, blunt spire, a short but broadish last whorl, a very contracted base, and a small slightly reverted snout; the whorls are longitudinally chamfred, have a small keel round the top, and rather broad spiral threads. *Sculpture.* Longitudinals—there are on the last whorl about 12, low ridge-shaped, straight ribs, which are not continuous from whorl to whorl, but increase rapidly in number up the spire; they are parted by furrows about three times their width; the last one, which is remote from the edge of the lip, is varicose; they become obsolete towards the point of the base. Spirals—below the suture are two well-marked furrows interrupted by the ribs and parted by a strongish thread, which forms a keel, and rises on the ribs into little tubercles; below this the whorls are more or less obsoletely scored by broad flat threads; these on the base and pillar are very distinct, though narrow, and are parted by broad, shallow, square-cut furrows. *Colour* smooth, porcellaneous white. *Spire* rather high, scalar, conical. *Apex* a blunt, round, smooth, glossy dome of 1½ embryonic whorls, whose tip is both immersed and flattened down, with a scarcely perceptible suture. *Whorls* 6, cylindrical, scarcely convex, angulated and flatly shouldered at the top; the last is short, slightly tumid, with a rapidly contracted base, from which projects the short, broad, conical, abruptly truncated snout. *Suture* angular and well marked by the projection of the shoulder below it. *Mouth* small, short, but broadish, angulated above, obliquely prolonged below into the square, open, slightly reverted

canal. *Outer lip* contracted and very slightly curved above, very patulous where the bend comes, and below this direct and oblique; it has about 10 small teeth within, of which the highest is remote from the top, and is larger than the others; just at this point is a slight open false sinus. *Inner lip*: there is a thin glaze on the body, the line across which is very straight, as is also the line down the pillar where the glaze forms a projecting border (without teeth), which runs out sharp and narrow to the very point; the point of the pillar is very obliquely cut off with a twist; the pillar itself is short, strong, and conical. H. 0·25. B. 0·13. Penultimate whorl, height 0·05. Mouth, height 0·11, breadth 0·06.

This belongs to the same group as *C.* (*P.*) *strix*.

Fam. OLIVIDÆ, *D'Orb.*

OLIVA, *Brug.*

1. *O.* (*Olivella*) *amblia*, n. sp.
2. *O.* (*Olivella*) *ephamilla*, n. sp.
3. *O.* (*Olivella*) *vitilia*, n. sp.

1. OLIVA (OLIVELLA) AMBLIA, n. sp. (ἀμβλύς, blunt.)

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Small, oval-oblong, glossy, white, with a short blunt spire, a conical base, and a small oval mouth. *Sculpture.* Longitudinals—lines of growth very faint. Spirals microscopic and obsolete. *Colour* porcellaneous white, more or less transparent. *Spire* short, convexly conical. *Apex* bluntly rounded. *Whorls* 4½, conical, barely convex, with a minute sharp scalar projection below the suture. *Suture* minutely channelled. *Mouth* oval, pointed and channelled above, slightly narrowed below. *Outer lip* sharp and thin, patulous; below, it projects in a blunt point on the right side, between which and the pillar is the broad, open, shallow canal. *Inner lip*: there is a thick, narrow, irregular-edged pad; this in front coils round the pillar, which is bent, twisted, short, truncated, and toothless. H. 0·15. B. 0·11. Penultimate whorl, height 0·06. Mouth, height 0·1, breadth 0·07.

In general size and proportions this a good deal resembles *O. spreta*, Gould; but that is lower in the spire, the peripheral breadth lies higher, the shell is more attenuated in front, the mouth is longer, and the pillar is more defined by a pad crossed at the point by two teeth.

2. OLIVA (OLIVELLA) EPHAMILLA, n. sp. (ἐφάμιλλος, a match for another.)

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Very small, oblong, glossy, white, with a high blunt spire, a conical base, and a long narrow mouth. *Sculpture.* Longitudinals—the lines of growth are barely recognizable. Spirals—there is scarcely a faint appearance of these. *Colour* probably porcellaneous white in the living specimen. *Spire* high, convexly conical, minutely scalar from a very small projection below the suture. *Apex* bluntly rounded. *Whorls* 4½, with a minute projection below the suture, very slightly convex at the sides. *Suture* minutely perpendicularly* channelled. *Mouth* oblong, small, pointed and deeply channelled above, slightly narrowed below. *Outer lip* sharp, prominent, regularly arched from the body to the point of the pillar, not being in the slightest degree emarginate in front. *Inner lip*: there is a thick, irregular-edged pad, which in front scarcely coils round the front of the bent, twisted, short, truncated, and toothless pillar. H. 0·16. B. 0·07. Penultimate whorl, height 0·04. Mouth, height 0·09, breadth 0·03.

The name of this little species is meant to signalize its remarkable resemblance to some of the minute *Achatinas*, such as *Cionella acicula*, Müll., or something between that and *Lovea leacociana* Lowe. Thinking it approached *O. tehuelchana*, d'Orb., I asked Mr. E. A. Smith to compare it with the type of that species preserved in the British Museum. He replies:—"I am sure that your shell is not *O. tehuelchana*, d'Orb. This has the whorls flat at the sides and separated by a sharply defined groove at the sutures; yours has the whorls a little convex in outline and differently canaliculate at the sutures." Than *O. myridiana*, Duclos, this 'Challenger' shell is much larger, is different in colour and texture, and has a much coarser spire and apex.

3. OLIVA (OLIVELLA) VITILIA, n. sp.

St. 24. Mar. 25, 1874. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. N. of Culebra Island, St. Thomas, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Small, oval, glossy, with a short, blunt, subscalar spire, and in front blunt and rather deeply sinuated. *Sculpture* scarcely

* *I.e.* parallel to the axis, in which sense I would propose to use the word "axially.'

any. *Colour* porcellaneous. *Spire* very short, roundedly conical, subscalar from the cylindrical rise of the whorls out of the perpendicularly sunk sutural channel. *Apex* very blunt and rather large, impressed. *Whorls* 5, very short, except the last, which occupies nearly the whole shell, rounded above, cylindrical below in the channel of the *suture*, which is axially impressed. *Mouth* oblong, pointed and channelled above, slightly narrowed below. *Outer lip* thin, scarcely prominent or arched, running out to a blunt point in front to the right, whence it is obliquely truncated backwards to the point of the pillar with a deepish cut. *Inner lip*: there is on the body a very thick prominent and irregular pad of glaze, which curves round the straight point of the pillar and there is 4-plaited, and, with a sharply defined edge, encircles the point of the shell. H. 0·26. B. 0·13. Penultimate whorl, height 0·035. Mouth, height 0·19, breadth 0·07.

The low spire, very blunt apex, and four plaits on the pillar-pad distinguish this species from *O. rosalina*, Duclos, or *O. rufifasciata*, Reeve (which Dr. Kobelt holds as = *O. mutica*, Say), or *O. inconspicua*, C. B. Ad. It is perhaps most like *O. pusilla*, C. B. Ad., which it resembles in lowness of spire and angularity at suture; but the spire is even lower than in that species, and the body-whorl is more tumid.

On some Points in the Morphology of the Test of the Temnopleuridæ. By Prof. P. Martin Duncan, M.B. Lond., F.R.S.

[Read December 15, 1881.]

(Plate VIII.)

Contents:—I. Introductory Remarks on the Subfamily *Temnopleuridæ*. II. Morphology of the Pits of *Salmacis sulcata*, Agass. III. The Sutures of *Salmacis sulcata*. IV. The Morphology of the pits, sutural marginal grooves, and of the sutures of Adult *Temnopleurus toreumaticus*, Agass., and of the Young form. V. The Pits and Sutures of *Salmacis bicolor* and *Amblypneustes ovum*. VI. Remarks on the pits, sutural grooves, and sutures. VII. Classificatory Conclusions.

I. *Introductory Remarks on the* Temnopleuridæ.

Desor, in his 'Synopsis des Echinides Fossiles' (1858), divided his tribe of Latistellate Regular Echini into the Oligopores and Polypores; and he separated the Oligopores—that is to say, the Echini with three pairs of pores to each ambulacral plate—into

three types. The second type he made to comprehend the genus *Temnopleurus*, Agass., and its allies, they being Echini with sculptured tests and ornamented with fossettes, or little cavities, at the angles of the plates. Their pores might be unigeminate or bigeminate *. This type has been called a subfamily of the family Echinidæ by A. Agassiz †, and the name of Desor has been appended to it. It has received much attention from nearly every naturalist who has studied the Echinoidea, and especially because some of the genera have persisted from the commencement of the Tertiary ages to the present day.

There have been ten genera associated with the subfamily, some of which belong to it without doubt; and the classificatory position of the others has been debated or enlarged upon by Desor, Lütken, and A. Agassiz. These authors, and also L. Agassiz, E. Forbes, Jules Haime, D'Archiac, Lovén, and Bell, have contributed to our knowledge of the superficies of the test of many of the species of the subfamily.

During the last twelvemonth a very large collection of fossil Echinoidea from Sind has been entrusted to Mr. Sladen, F.L.S., and myself, by the Superintendent of the Geological Survey of India, for description; and amongst those specimens which had been derived from the Eocene rocks there were many which would be called Temnopleuridæ, and some forms which required very careful consideration before they could be classified therein—such, for instance, which had a ribbed ornamentation around the primary tubercles and extending across the median space of the interradials, the spaces between the ribs resembling those drawn by A. Agassiz in *Trigonocidaris*. But the spaces were not really, to my mind, either sutural impressions or little cavities at the angles of the plates. In fact, I found the classificatory difficulties great.

Wishing to have some definite information concerning the morphology of the cavities at the angles of the plates and the meaning of the sutural depressions, I sought for information in the writings of my predecessors, and obtained recent specimens from the southern coast of Sind. The desired information has been found exceedingly meagre. In fact, so far as I have been able to discover, no one has examined the deeper connexion of

* Desor, 'Syn. Ech. Foss.' p. 50.

† A. Agassiz, 'Revision of the Genera of Echini,' p. 460.

the pits (as the cavities at the angles of the plates are properly called), or has satisfactorily explained the nature of a sutural depression.

I was impressed that the classification would be rendered more satisfactory by a careful examination of the nature of the cavities or pits at the angles of the plates, and of the so-called sutural depressions or furrowings.

II. *Morphology of the Pits of* Salmacis sulcata.

In order to be exact, it is necessary to call the openings and cavities at the angles of plates "pits," and not pores. The suture of two adjoining plates is really the whole junction of their edges; so that the superficial line denoting this on the surface of the test should be called the margin of the suture.

Specimens of *Salmacis sulcata,* Agassiz, of many dimensions and ages were examined in the first instance.

On referring to the 'Revision of the Echini' by A. Agassiz (p. 471), in reference to the genus it is noticed, "angular pores at junction of plates." With regard to the specific diagnosis, it is stated that the sutural pores are slightly larger than those of the species *Salmacis bicolor*, Agass. On turning to the description of that species, it will be found stated, "The pores at the median junction are small, and the horizontal sutures of the coronal plates slightly furrowed." In other words, the pits are small and the margin of the suture is slightly furrowed.

On examining the specimens before and after fracture, it was evident that in *Salmacis sulcata* the pits at the angles of the sutures, in the median interradial and ambulacral areas, occupied what might have been the point of one plate and part of the line between the edges of the adjoining plates, and that at the junction of the tentaculiferous plates with the interradials there was a vertical series of pits also interfering with the perfect shape of the interradial plates. In fact, in some specimens the pits, as a whole, seem to interfere considerably with the continuity of the test, and would also seem to leave but little edge to some plates on which sutural junction could take place.

A Notice of the Nature of the Pits and Sutures of Salmacis sulcata, *Agass.*—The pits of the test of *Salmacis sulcata* are in the median lines of the ambulacral and interradial areas, and also at the junction of the interradial plates with the tentaculiferous

plates of the ambulacra. The external dimensions of the pits along the median lines are much smaller than and afford no indication of their inner development. These pits pass deeply into the test and enlarge within, especially actinally and abactinally, or in the vertical direction, and less so laterally.

In the interradial areas each pit leads to a compressed flask-shaped cavity with a broad bottom. It does not perforate the inner part of the test, but reaches inwards to within a very short distance of the inner part of the edge of the plates, where there is a layer of the usual reticulate, calcareous structure of the test.

Each pit occupies space in the edges of the approximated plates, and is surrounded, except superficially, by more or less projecting reticulate tissue, and is separated by it from the pits above and below on the same line (Plate VIII. fig. 3). In some instances the pits unite deeply with a neighbour; so that if the outline of the flat flask-shaped hollow were marked on the outside of the test, to show its relation in point of size to the opening of the pit, it would occupy an elliptical space three times the dimensions of the orifice. As each plate is in relation with three median pits, a considerable part of its edge is hollowed out, the surface of the test being undermined.

In the median line of the ambulacral areas the pits enlarge as they pass inwards, are deep, flat flask-shaped, elongate vertically, narrow from side to side, and frequently have a projection on their floor. They occupy less space than the interradial series, but undermine the plates close to their edges. It is perfectly evident that the interradial, as well as the ambulacral pits of the median lines are depressions on the faces of the opposed edges of adjoining plates (Plate VIII. figs. 3 & 8).

The small pits between the tentaculiferous ambulacral plates and the interradials pass inwards as cylindrical spaces ending in *cul de sacs*; some bend in their course, and others enlarge slightly (Plate VIII. figs. 6 & 7).

It is evident that in *Salmacis sulcata* the pits, which are of moderate dimensions at the surface of the test, occupy much more space within it. They are lined with a continuation of the ordinary derm of the outside of the test, and do not appear to contain any special structures. They sometimes communicate, within, with one another.

On examining one of the interradial plates, the apex of its angle, which is received between two corresponding interradials,

will be found to be blunt and even slightly concave; and this loss of substance is to accommodate the pit (Plate VIII. figs. 1 & 2, *a*, *b*). Opposite to this concavity is the horizontal suture between the associated interradials; and there is loss of test on their edges close to the commencement of the suture. The margins of the sutures, both vertical and horizontal in direction, are faintly grooved; and in large specimens there is a distinct shallow pit on the vertical series, between each larger pair of pits (fig. 2, *c*).

The shallow pit is a mere depression; yet it occupies what might have been solid test, and it diminishes the amount of plate-edge available for junction or suturing with its fellow.

The line of junction between the interradials and the tentaculiferous plates of the ambulacra is marked, not only by a pit at the commencement of the horizontal interradial suture, but also by four, and sometimes five, well-developed and deep pits at the junction of the sutures of the small ambulacral plates. Hence on the surface of the test the interradial area is attached to the ambulacral by a series of very small processes, across which a faint vertical sutural line can be seen.

III. *The Sutures of* Salmacis sulcata.

This development of the pits appears to relate to the very remarkable sutures of the species.

The sutures of the interradial plates are four in number. Each plate is joined by its abactinal edge to the plate above; by its actinal edge to the plate below; by a lateral median angular suture to the plate at its side; and by a lateral suture to the plates of the ambulacrum close by. The first two sutures are horizontal, and the others are more or less vertical in direction.

On carefully separating two interradial plates of a vertical series, along the horizontal suture, the tissue connecting their edges (that is to say, the suture) is seen. The abactinal edge of the lower plate is minutely, but very distinctly, marked with from two to four rows (from without inwards in the normal position of the test) of hollows or sockets. The rows are separate, and extend over the breadth of the edge not quite close to the ends. The sockets are limited, deep, and are special structures in the reticulate calcareous tissue of the plate (Plate VIII. fig. 5). The test is brilliantly white; and although the sockets can be seen with a hand-lens without difficulty, some careful arrangement of the light transmitted by the bull's-eye, or reflected from

the stage-reflector, is necessary. The specimen, fixed on wax, should be moved on its axis by the rotating-stage so as to cast shadows in different directions. This proceeding is especially necessary in carrying out some of the following observations.

On looking at the actinal edge of the interradial plate next in vertical succession to that just mentioned, it will be found to be covered with a considerable number of minute, well-defined, blunt, conical projections of the reticulate calcareous tissue of the test. These knobs can be seen from the outer surface of the plate, extending beyond it. They are in rows; and when the two plates are in accurate and normal contact, the knobs fit into the sockets of the lower plate (Plate VIII. fig. 4). The only place where this knob-and-socket arrangement is deficient is quite at the end of the edge of the plates, where the pit runs in for a short distance. Each interradial plate has a series of knobs on its actinal edge, and sockets on the abactinal edge.

The ambulacral areas are occupied by two vertical series of plates, separated by a zigzag vertical suture along the median line, and they are flanked by the numerous small, pored plates of the tentaculiferous series. Each large ambulacral plate has an actinal and abactinal horizontal edge, an angular suture uniting it with two neighbouring plates along the median line, and an opposite end, to which are attached the small plates of the poriferous zone. The abactinal edge of each of the large ambulacral plates is covered with minute knobs of the reticulate tissue, and its actinal edge has rows of sockets; so that the lower or actinal edge of one plate receives the knobs of the abactinal edge of the plate below, an arrangement exactly the reverse of that which exists in the interradial areas. The pits interfere but slightly with this arrangement, as they are almost out of the way and close to the outer angle.

The vertical sutures of both areas being in relation to the large pits of the median lines, are very different in their construction to those just noticed, and must be considered in detail.

First. The median zigzag suture of the interradial area, which unites the broad interradial plates side by side.

The edge of a plate in this position forms the sides of an angle; and, as before noticed, these large pits excavate its surface. Each expanded pit is separated from its neighbour on the same plate-edge by a projection, which is broad toward the outer surface of the plate and narrower inwards. There is also a shelf-like pro-

cess along the inner part of the edge, bounding the expanded part of the pit inwardly. There are knobs of reticulate tissue on alternate projections and sockets on the others. Moreover, on one projection along its broadest part is an elliptical shallow cavity, and on the next a convexity occurs in the corresponding position. Knobs are found on the shelf-like process in little groups, and then hollow sockets in groups, and so on. The knobs and sockets, grooves and convexities of one plate-edge correspond with sockets, knobs, convexities, and grooves in the edge of the opposed plate. These are the sutural structures; and they also limit the dimensions of the pits (Plate VIII. fig. 3).

A very similar series of structures is seen on the median angular edges of the ambulacral plates. The pits are separated by distinct pillars enlarging outwards, and merging inwards into a shelf-like structure, on which the pit ends inwardly. The knobs and sockets are on alternate pillars; and the enlargement of the one carries a long convex mass, and that of the other an elliptical cavity. Usually there is a projection at the bottom of each pit, from the shelf-like process. The knobs and sockets of one ambulacral plate fit into sockets and knobs on the edge of the opposite plate normally in contact, and act as sutural processes (Plate VIII. fig. 8).

Finally, there are sutures between each interradial plate and the small tentaculiferous plates of the ambulacra. The small pits are more or less in vertical series. On the interradial plate-edge, sections of the pits are seen separated by broad processes running inwards, and merging into a well-developed inner reticulate tissue. The processes and this tissue are studded with well-developed sockets (Plate VIII. fig. 6). But on the corresponding edges of the ambulacral plates the similar processes and inner shelf-like tissue are covered with knobs which stand out well (Plate VIII. fig. 7); these fit into the sockets of the corresponding interradial plate, and constitute the suture.

There is very slight and probably no absolute junction between any plates by continuity of reticulate tissue; but the suturing consists of these elaborately alternate systems of knobs and sockets, and of projections and corresponding grooves.

The breadth of one of the knobs is commonly $\frac{1}{300}$ inch, and the height is rather more. The sockets correspond in size.

IV. *The Morphology of the Pits, sutural marginal Grooves, and Sutures of* Temnopleurus toreumaticus, *Agass.*, 1841.

The pits of all the areas are very visible in this typical species of the genus *Temnopleurus*; and there are marginal sutural grooves of a very distinct kind. The pits have a considerable inward oblique and vertical extension within the test; their inner dimension varies according to position; and they occupy depressions in the edges of adjoining plates.

At the ambitus especially the principal tubercle of each interradial plate, or a process of its scrobicule, comes close to the actinal edge and covers and obliterates, to a greater or less extent, the marginal grooving. So that when the plate is separated from the one below, or that which is placed orally to it, the base of the tubercle, or a prolongation of its subscrobicular structure, is seen to project into a concavity on the outer surface of this lower plate close to the abactinal sutural part.

This deep grooving of the sutural margin and of the superficies of the test close to it, coupled with the existence of the great primary tubercle with its basal structure, interferes with the thickness of the actinal and abactinal edge of the plates. The thickness is greatest in the central part of the edge, and thence there is a gradual thinning on either side. The actinal edge of each interradial plate is covered with numerous knobs, rounded at the end, and of the same character as those noticed in *Salmacis sulcata*. Sometimes the knobs are placed irregularly; and in some places they are in lines, and then one knob runs into another, and a line of elevation is produced and is more or less continuous. On the abactinal edge of the plates there are sockets which correspond with the knobs and lines of elevation of the adjoining plate. (Plate VIII. figs. 10 & 11.)

In the ambulacral areas the median pits are deep, oblique, and not much expanded within. The grooving of the margin of the suture is very decided towards the median line, and less so towards the poriferous zone; and, in the first place, the thickness of the plate is greatly reduced. Hence the outline of the horizontal sutural edges of the ambulacral plates is irregular. The actinal edge of each plate has numerous sockets, which receive the knobs of the abactinal edge of the plate below. Thus there is the same reversal of the direction of the knobs and sockets, with regard to those of the interradial areas, as was noticed in *Salmacis sul-*

cata. The tentaculiferous plates, or the poriferous parts of the ambulacral plates, have knobs and sockets arranged like those of the main plate.

On examining the edges of the interradial plates along the median line the succession of pits is very distinct. They enlarge, as has been stated already, slightly at their inner end in the vertical direction, and reach inwards very close to the inner margin of the edge. On either side of a pit, that is to say actinally and abactinally in vertical succession, there is a curved process passing from the inner part of the edge outwards, and then bending close to the outer part of the edge towards the angle of the plate (Plate VIII. fig. 12). These processes, two to each plate, enclose a space; and one of them has one series of sockets, and the other one series of knobs on it. The space is shallow and oblique, and is part of a pit. On the inner part of the edge, below the space and the end of the pit, there are groups of minute knobs and sockets. On the corresponding edge of the contiguous plate the same structures are found; but the position of the knobs and sockets is reversed, and there is a slight projection which fits partly into the space. The suturing is by the reception of the knobs by the sockets of the approximated plate-edges.

A similar arrangement occurs on the median edges of the plates of the ambulacral area; but there is more variation in the extent of the processes with knobs and sockets.

In parts of the test where the pits are unusually large, there is more than one series of processes, and a set of knobs and sockets bound the space or projection, as the case may be. On the other hand, near the peristome, where the pits are small, cylindrical, and yet pass far inwards, the suturing is by nearly straight lines of pits and sockets, which are parallel with the pits and are small.

The junction of the outer edge of the interradial plate with the poriferous plates of the ambulacrum is complicated by the presence of the pits at the end of the horizontal marginal grooves (actinal and abactinal), and by occasional pits at the junction of the sutural lines of the small plates with the interradial. But the suturing is by two to four processes, separated or not by pits, and passing from the inner part of the edge of the plate to the outer, just below the surface.

The processes consist of two laminæ of the reticulate tissue of the test; and between them are sockets in a series, or they may

run together and form linear depressions. The inner part of the edge internal to the base of the processes is crowded with sockets (Plate VIII. fig. 13).

Finally, the edge of the poriferous plates in contact with the interradial is marked by series of knobs which fit into the sockets in the corresponding interradial edge (Plate VIII. fig. 14).

The plates of the apical disk do not join the coronal and ambulacral plates by any knob-and-socket suture, but by a slight overlapping.

It is perfectly evident that the union of the edges of the plates of *Temnopleurus toreumaticus* and of *Salmacis sulcata* only differ in matters of slight detail. In both there is a reversal of the arrangement seen in the interradial area in the ambulacral; and in both the poriferous plates have knobs and join the interradial plates which are socketed.

Young Forms of Temnopleurus toreumaticus.—Several specimens of from $\frac{1}{3}$ to $\frac{1}{2}$ inch in diameter were examined. There are round, widely open shallow pits, the bottom of which can be seen from the surface of the test above the ambitus in both areas, and the marginal sutural grooving is slight. At the ambitus in some, but not in all, the pits and grooves diminish in size, and are often very small; and below the ambitus, in all, the pits of the ambulacral area are not so large as they are near the apex, and those of the interradials are very minute.

The edges of the interradial plates, along the vertical median line, show that the pits barely pass within the test near the peristome, and that they are deeper near the apical system; but they do not excavate the point of the angle of the plates. Where largest, they do not pass inwards more than in *Amblypneustes*. In fact, the flask-shape is not seen.

The suturing is different to that in the adult form; and it consists, where the pit is very insignificant, of well-developed rows of knobs, parallel with the outside of the test, or slightly irregular in their distribution, and of sockets arranged in similar order. The knobs are on one side of the pit and the sockets on the other; and they correspond with sockets and knobs on the opposed plates. Where the pits are larger and the sutural marginal groove is more pronounced, the knobs and sockets are in arcs, and frequently there are lines of knobs run together to form a linear elevation; and there are corresponding lines of depression. Here and there one of these lines has a distinctly inward track,

and passes from close to the outside of the test to the inner part of the edge.

The edge of the interradial plates in contact with the poriferous plates of the ambulacrum has two rows of large sockets parallel with the surface of the test. There are no other pits to be seen there, except those at the ends of the horizontal sutural margins between the interradial plates.

A more confused knob-and-socket arrangement is seen on the median edge of the ambulacral plates than on the corresponding edge of the interradials. But there is a general resemblance. The deepest pits are near the peristome; and on either side of them, on the edge of the plate, are confused nodules and depressions rather than well-defined knobs and sockets. Moreover, the running together of the knobs and sockets, respectively, in lines occurs, and the solitary lines passing from without inwards are visible. The deepest pits near the peristome, four or five in number, hold sphæridia of considerable dimensions.

The edge of the poriferous plates in contact with the interradium has two large rows of knobs; and here and there they run together to form rounded-off wedges. This arrangement is much more simple than in the adult form; and is seen less distinctly towards the apical part of the ambulacrum.

Finally, the actinal and abactinal edges of the interradial and ambulacral plates have a small number of knobs and sockets.

V. *The Pits and Sutures of* Salmacis bicolor *and* Amblypneustes ovum.

Salmacis bicolor.—The pits in this species are small externally; but they pass down far towards the inner part of the test, as cylindrical tubes (Plate VIII. figs. 15–17). A very considerable development of knobs and sockets is found on the median interambulacral and ambulacral plate-edges, and lines of more or less continuous depression and elevation also occur. The suturing is slighter than in the other species, but the knobs are often larger. The same kind of suture is found between the interradial plates and the ambulacral poriferous plates as in the species already mentioned. But the knob-and-socket suturing of the actinal and abactinal horizontal edges of the plates, coronal and ambulacral, although it exists, is slight and often difficult to see. Here and there it is replaced by linear elevated tracts and corresponding long depressions.

Amblypneustes ovum.—A small specimen of this species, in which the pits are mere depressions and barely pass inwards, was examined. There are traces of the peculiar suturing to be detected here and there; but a more bulky convexity enters an irregular concavity on the edges, in most parts. It is the faintest expression of the very marked structures of *Salmacis sulcata.*

VI. *Remarks on the Pits, Sutural Grooves, and Sutures.*

The pits are more than simple depressions of the marginal sutural lines; and when fully developed, as in *Salmacis sulcata* and *Temnopleurus toreumaticus*, they occupy space in the edges of contiguous plates and portions of the test at the angles. They commence, in the young form, as depressions on the sutural margin; and as the test increases in thickness the pit becomes deeper, not only from the outward growth of the test, but also from the inward growth and extension of the base of the cavity. Each pit is a hollow in the approximated edges of two joining plates, and some pits certainly communicate by their expanded bases. The pits undermine considerably, close to the edges of the test in some instances, and are lined with a continuation of the outer derm of the test. Lovén found sphæridia in those nearest the peristome in the median ambulacral areas; and I can testify to their occurring as high as the sixth pit in the young form. Elsewhere no special structures are in relation to the pits. Similar developments are not known in any other subfamily of the Echinoidea.

The groovings and depressions along the line of the sutures, so visible in *Temnopleurus*, and of much less significance in *Salmacis*, increase with the age of the individual in the first-mentioned genus; and it is evident that they add in the first genus to the extent of the superficies of the test. They may be broad or narrow, deep or shallow, and their continuity may be interfered with by vertical dissepiments or tubercles. They have an importance in the economy of the animal; and they may be slight, and yet the pits may be large. They are absolutely depressions between ridges on which tubercles are placed above the normal level of the plate, and which are ornamental elevations, as in *Temnechinus*, which has no true pits, and *Trigonocidaris.*

The sutures are composed of the ordinary reticulate transparent calcareous tissue of the test. The knobs are more or less hemi-

spherical; and their free surface is not one of fracture, but is perfect. Some are elongate, and others are elliptical and even very long at their base. The size varies in the species; and $\frac{1}{300}$ inch may be taken as a common diameter and height. The sockets are corresponding depressions in the edges of the plates; and their surface shows an even, unbroken, calcareous reticulation. They receive the knobs; and no derm passes down, from without inwards, in the line of suture to separate them. The processes on and between which the knobs and sockets are placed in adult forms, are boundaries of the sides of the pits; and I think that now and then there is continuity between the opposed processes of the two adjoining plates.

The number of the knobs and sockets is immense; and they are found on all the plates, which may amount to more than 1500 in a well-developed *Salmacis sulcata*. The test, as a whole, has no other bonds of union than these sutures; but the generative and ocular plates are not sutured with the others. When whole, the tests will stand considerable pressure; but when partly broken, they fall readily to pieces. The suturing is of a kind which is used in carpentry in making tables, and especially in uniting hollow spheres made up of pieces, when outer and inner bracing is not possible. It is called dowelling. I have not found this method of suturing in other genera; but irregularities of surface on the edges of plates are seen in some. Thus, in *Diadema setosum* there is a faint trace of an irregular suturing by processes.

VII. *Classificatory Conclusions.*

It would appear, from what has been written concerning the sutural depressions and pits, that it is not unreasonable to separate those Echinoidea with true pits from those which have only sutural grooves or depressions between raised ornamentation, and to consider the grooved forms, which are not pitted, more embryonic than the others.

The species which were described by MM. D'Archiac and Jules Haime from the Nummulitic rocks of Sind were placed by them under the genus *Temnopleurus*. But they have no true pits, only well-marked broad grooves over the margins of the sutures; and these grooves are really parts where the raised ornamentation of the test does not exist.

Desor states, in his 'Synopsis des Échinides,' p. 105, with reference to *Temnopleurus*:—"C'est par erreur aussi que M. Forbes prétend qu'il existe des pores aux angles des plaques coronales comme dans les *Salmacis*." Now typical *Temnopleuri* certainly have pits at the angles of the plates, and something more than deep sutural impressions there. Hence the Nummulitic forms are not true members of the genus *Temnopleurus*. The numerous members of the subfamily Temnopleuridæ which Mr. Sladen and myself are now describing from the lowest Nummulitic rocks have very decided rib-like ornamentation, and, of course, what are called grooves; but they are not pitted. So that all these Eocene forms from Sind must come under one or more genera with a raised rib-like ornamentation, without pits. They resemble in many points *Trigonocidaris*, Agass., and *Paradoxechinus*, Laube.

With regard to forms having pits, *Temnopleurus* is typical. The generic differentiation of *Salmacis sulcata* and a typical species of *Temnopleurus* is insufficient. *Amblypneustes* is approached through *Salmacis bicolor*. I do not think it possible to admit *Temnechinus maculatus*, A. Agass., amongst the Temnopleuridæ with pits until Agassiz has examined the sutures.

If the subfamily is to be rearranged according to these views, the oldest forms will form the group with depressions on the test in the line of the sutures, or, rather, with raised ribs.

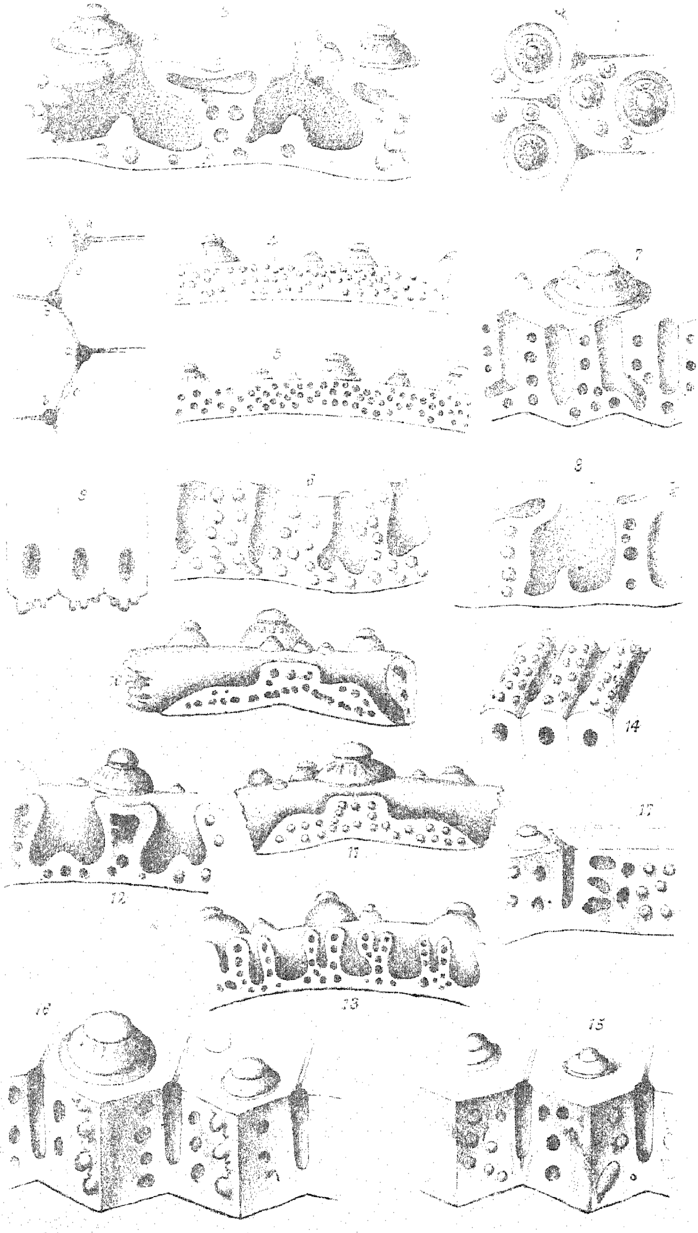
The second group will consist of the genera *Temnopleurus*, *Salmacis*, and *Amblypneustes* and others with true pits.

It is interesting to note that the earlier forms of the Temnopleuridæ resemble the immature individuals of recent species, and that the immature individuals of *Temnopleurus toreumaticus* might be associated with some species of *Salmacis*.

DESCRIPTION OF PLATE VIII.

Fig. 1. *Salmacis sulcata*. Superficial view of the pits on the interradial median line. The sutural markings are distinct; and each pit transgresses on the substance of the angle of a plate especially. Magnified.

Fig. 2. An older specimen. The sutural marginal lines are more distinct. The pits are about the same size as in fig. 1; but there are depressions or semi-pits on the vertical sutures between the others *a* and *b*



Berjeau lith. Hanhart imp.

STRUCTURE OF THE TEST OF
TEMNOPLEURIDAE.

are pits in relation to the angles of plate; *c* are the semi-pits. Magnified.

Fig. 3. The edge of an interradial plate along the vertical or median series of sutures. *a* and *b* are the parts of the pits pertaining to the plate, the rest being in the adjoining interradial. *c* is the semi-pit. The great development of the pits below the surface is seen; and they are separated by projections of the plate's edge, broad above, narrow below. These projections carry the sockets and knobs of the suture. Below *c* there is a long socket followed by three pits; and below the large tubercle a long projection is seen, and below it more knobs. Beneath the expansion of the pits, on the reticulate tissue of the test, are some knobs and sockets. Magnified.

Fig. 4. The actinal edge of the same plate. A series of knobs projects. Magnified.

Fig. 5. The aboral edge of an interradial plate, showing three or more irregular rows of sockets. Magnified.

Fig. 6. View along the line of suture of the ambulacral tentaculiferous plate and the interradial plate; the edge of the ambulacral plates is drawn. The deep and narrow pits (in section), some expanding, are shown; and between them are numerous knobs. These fit into the sockets in the interradial plate (fig. 7). Magnified.

Fig. 7. An interradial plate, ambulacral edge: the portions of pits correspond with others on the ambulacral edge, the raised lines between the pits carry sockets. Magnified.

Fig. 8. View of the edge of a median ambulacral plate along the line of vertical suture. The pits are large, and they extend on the edge of the plates They are separated by ridges, some knobbed and others with sockets. A process arises on the floor of the pit which is sutural. Magnified.

Fig. 9. An ambulacral series from within the test. The tentaculiferous pores are seen, and on the edge a number of minute knobs. Magnified.

Fig. 10. Abactinal edge of a coronal plate of *Temnopleurus toreumaticus*, showing sockets, some in linear series. Magnified.

Fig. 11. An actinal edge of an interradial plate near the apical system, showing knobs. Magnified.

Fig. 12. The median interradial suture and pits. Magnified.

Fig. 13. The suture and pits of the interradial plates adjoining an ambulacral area: sockets and pits. Magnified.

Fig. 14. Knobs on the ambulacral plate-edges in relation with sockets on the corresponding interradials. Pits are shown. Magnified.

Figs. 15–17. *Salmacis bicolor.* The median interradial suture, showing pits and knobs, sockets, elevations, and depressions. Magnified.

Mollusca of H.M.S. 'Challenger' Expedition.—Part XIII.

By the Rev. R. Boog Watson, B.A., F.R.S.E., F.L.S.

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[Read March 16, 1882.]

Fam. Buccinidæ, *Flem.*

Buccinum, *L.*	Nassa, *Lam.*
Phos, *Montf.*	

Buccinum, *L.*

1. *B. albozonatum*, n. sp.	2. *B. aquilarum*, n. sp.

1. Buccinum albozonatum, n. sp.

St. 155 D. Jan. 20, 1874. Lat. 49° 28′ S., long. 70° 13′ E. Royal Sound, Kerguelen. 28 fms. Mud.

Shell.—Small, thin, fusiform, with a high spire, a short base, and a small snout, of a ruddy brown, tipped and banded with white; it has spiral threads. *Sculpture.* Longitudinals—on the earlier whorls there are some feeble folds below the suture; only sharpish hair-like lines of growth elsewhere. Spirals—over the whole surface there are flat threads with furrows of equal breadth between them: of these, on the penultimate whorl there are about 10; on the snout they are finer and closer. *Colour* muddy brown, with a transparent white-tipped pillar and central band on each whorl. *Spire* high, rather narrow. *Apex* blunt, rounded, with a slightly immersed tip. *Whorls* 6, regularly convex; the last contracts slowly on the base, and is produced into a short, one-sided, slightly expanded, truncated snout. *Suture* rather deeply impressed. *Mouth* largish, oval, open, straight, bluntly pointed above, pro-

duced into a small, short, oblique canal below. *Outer lip* thin, blunt, rather patulous, slightly sinuated and angulated a little way below the suture, and below this flatly arched. *Inner lip*: a very thin and narrow glaze covers the arched body and the straight pillar, which is not thickened or twisted, but is obliquely cut off in front. *Operculum* is intermediate in form between that of *Buccinum* and *Cominella*; for, as in the latter, the nucleus is at the lower end, but it is not apical but is within the edge towards the outer margin as in the former. H. 0·4. B. 0·18. Penultimate whorl, height 0·1. Mouth, height 0·19, breadth 0·11.

2. Buccinum (?) aquilarum, n. sp.

St. 78. July 10, 1873. Lat. 39° 26′ N., long. 25° 13′ W. Off San Miguel, Azores. 1000 fms. *Globigerina*-ooze.

Shell.—Small, thin, white, ventricose, biconical, oval, subscalar, with an oval, slightly oblique mouth, and a short canal. *Sculpture.* Longitudinals—on the upper whorls there are many feeble, close-set, straight riblets, which are very faint and merge into the lines of growth on the last whorl. Spirals—on the whole surface are fine, rounded, spiral threadlets parted by shallow furrows which are broader than the ribs. *Colour* semitransparent white, under a thin yellow membranaceous epidermis. *Spire* short, broad, conical, subscalar. *Apex* small, but rounded. *Whorls* 6, slightly flattened above; below this there is a very blunt angulation, and the lower part of each whorl is subcylindrical; the last whorl is ventricose, contracting on the base to a very short, rather lop-sided snout. *Suture* impressed. *Mouth* rather large, oval, rounded at the top, and prolonged below into an oblique, short, open canal. *Outer lip* thin, but not sharp, very bluntly angulated near the top, of regular curve, open, with a very slight basal cut at the point of the pillar. *Inner lip*: a thick layer of glaze, with a prominent edge continuous with the outer lip, runs down parallel to the belly-margin, and is cut off by the oblique canal at the point of the pillar, which is neither swoln nor thickened. H. 0·33. B. 0·21. Penultimate whorl, height 0·07. Mouth, height 0·22, breadth 0·13.

This is a perplexing form, in general aspect very like several *Admetæ.* Than *A. ovata*, E. Sm., from Japan, it is very much higher and more attenuated in the spire; than *A. crispa*, Möller, it is much more tumid, and lower in the spire; than *A. viridula*,

Fabr., it is more delicately sculptured, is higher in the spire, and is of slower increase. The absence of the generic teeth on the pillar and the presence of the slight basal sinus are both features not without parallel in the genus *Admete*; but in all *Admetæ* so far as known to me there is a varicose twist at the point of the pillar, between which and the edge of the inner lip lies a more or less distinct umbilical chink or furrow. In this 'Challenger' shell there is no swelling whatever, and scarcely any twist even in the sculpture, and not the slightest approach to an umbilical chink. The absence of the varicose twist is, indeed, rather an objection to putting this species under *Buccinum*; but that genus already accommodates forms still more exceptional than the present one. *Volutharpa* is perhaps nearer; but I do not sufficiently know the limits of that genus to take liberties with it; the absence of an operculum, which seems its only positive claim to generic standing, is a feature out of recognition in the present case.

PHOS, *Montf.*

1. *P. naucratoros*, n. sp. | 2. *P. bathyketes*, n. sp.

1. PHOS NAUCRATOROS, n. sp. (ναυκράτωρ, master of the fleet, Admiralty.)

St. 219. March 10, 1875. Lat. 1° 54′ S., long. 146° 39′ 40″ E. Admiralty Islands, N.E. of Papua. 150 fms. Mud.

Shell.—Strong, smooth but not polished, yellowish white, with some pale ruddy bands, with a high conical spire, small sharp apex, and a slightly impressed suture. Whorls rounded, with narrow ribs and spiral threads, a short contracted base, and a twisted pillar. *Sculpture.* Longitudinals—on the last whorl there are about 15, on the earlier about 18, rather narrow, raised, rounded, flexuous ribs, of which one on each whorl is a little larger than the rest; they extend to the upper suture and also to the point of the base, they are parted by rounded furrows of twice their breadth; the lines of growth are extremely numerous and sharp. Spirals—the whole surface is densely packed with strongish, but very unequal, rounded threads parted by fine small furrows; there is a broad shallow furrow round the upper part of the pillar, and in it the spiral threads are sharper and sparser than elsewhere. *Colour* porcellaneous white, stained with yellow on the surface, banded with palish rufous and white. *Spire* high, narrow, conical. *Apex* small and sharp, consisting of four bicarinated, conically shaped,

conical whorls. *Whorls* 10, rounded, constricted below and contracted above; the last is a little tumid, with a short rounded base, which is produced into a short, broad, lop-sided scoop-like snout. *Suture* small, impressed, rather oblique. *Mouth* irregularly oval, pointed above, subangulated at the pillar, and produced in front into the short, open, oblique canal. *Outer lip* thickened by the external callus, in advance of which it is thin; within, it is scored with long narrow teeth; there is a slight open sinus near the body, its curve is a little angulated in front, from which point in particular it is patulous; the broad notch of the canal has a slightly reverted lip. *Inner lip* flat on the body, bluntly angulated at the base of the short pillar, which is swoln and twisted in front, and coarsely flanged on the edge; the extreme point of the pillar is very small and sharp, and is as prominent as the point of the outer lip; the labial pad is very thin and undefined. H. 1. B. 0·5. Penultimate whorl, height 0·2. Mouth, height 0·5, breadth 0·27.

The extreme tip of the apex in the only specimen present is broken. The species presents that feature which is peculiar to the whole genus, of strong family resemblance, but is quite distinct from all the species so far as known to me.

2. PHOS BATHYKETES, n. sp.

St. 210. Jan. 25, 1875. Lat. 9° 26′ N., long. 123° 45′ E. Philippines. 375 fms. Mud. Bottom temperature 54°·1.

Shell.—Thinnish, porcellaneous, without lustre, brownish yellow, with a high conical spire, small turbinated apex, short rounded whorls having feeble ribs and spiral threads, deep suture, small body-whorl, short contracted base, and a broad, deeply nicked snout. *Sculpture.* Longitudinals—on the first regular whorl there are 11 or 12, on the body-whorl about twice as many, narrow, slightly prominent, rounded riblets, which extend from the suture to the point of the base; they have a sinistral trend, which is very marked on the base; they are parted by shallow furrows two or three times their breadth; the lines of growth are fine, sharp, and equal. Spirals—on the penultimate whorl there are about 6, on the body about 12, narrow rounded threads, which rise into sharpish little tubercles in crossing the riblets; the fourth of these lies about the periphery, and the furrow between it and the third is wider than the others; in all of these furrows are feebler threadlets. The front of the pillar has a strong

twisted swelling. *Colour* dull brownish yellow, which is a little deeper on the tubercles. *Spire* high, narrow, conical. *Apex* slightly abrupt, consisting of 3½ turbinated embryonic whorls, of which the extreme tip is very small; they are smooth and rounded, but slightly keeled above the suture; towards the first regular whorl the carinating thread becomes double or triple, and a few very oblique riblets appear. *Whorls* 9½, short, rounded, being pretty equally constricted above and below; the last is small, being neither broad nor long; the base is short and conical, being drawn out into a broad, lop-sided, slightly reverted snout, in which lies the deep, wide, rounded nick of the anterior canal. *Suture* very deeply impressed, rather oblique. *Mouth* semioval, obliquely produced in front and abruptly truncated at the point; it is hardly angulated above. *Outer lip* has a feeble varix outside, formed by a crowding at that point of the longitudinal riblets; the edge is sharp, flatly arched, scored internally with long narrow teeth, which are alternately stronger and weaker; it is slightly emarginated below the suture, prominent in front, and then retreats to the edge of the canal, and here alone it is patulous. *Inner lip* short across the body, where the labial callus spreads somewhat; and there in the middle is a strongish little tooth; the junction of body and pillar is rather concave; the pillar, which is longish and somewhat swoln, is very obliquely cut off and twisted, with a narrow rounded edge; two strongish and one or two feeble teeth cross it almost horizontally; and it runs out in front to a very fine, attenuated, but blunted point. H. 0·9. B. 0·35. Penultimate whorl, height 0·16. Mouth, height 0·36, breadth 0·17.

This species is a good deal like *P. borneensis*, Sow., from Borneo, but is slightly slimmer; the first whorls here are larger, the suture is deeper, and between the spirals the shell is smoother. In Sowerby's species, too, the upper angle of the mouth is much more deeply sinuated, and behind this canal is an angulated callus, the pillar is shorter and less sharply pointed, and there is no tooth on the body; the ribs in that species are stronger and closer set, and are frequently developed into varices, of which, with the exception of the feeble labral swelling, there are none in the 'Challenger' species.

NASSA, *Lam.*

1. *N. levukensis*, n. sp.
2. *N. psila*, n. sp.
3. *N. brychia*, n. sp.
4. *N. babylonica*, n. sp.
5. *N. agapeta*, n. sp.
6. *N. capillaris*, n. sp.
7. *N. ephamilla*, n. sp.

1. NASSA LEVUKENSIS, n. sp.

July 29, 1874. Levuka, Fiji. 12 fms.

Shell.—Thin, rather smooth, brownish livid, ovate, subfusiform, scarcely oblique, with a short, subscalar spire, and a small but bluntish apex; the anterior canal is very shortly but sharply margined, with scarcely any snout. *Sculpture.* Longitudinals—the earlier whorls are crossed by numerous rather fine straight riblets parted by similar furrows; these ribs and furrows increase in strength, but not proportionally so, down the spire, and tend to become obsolete on the body-whorl; the lines of growth are fine, smooth and unequal. Spirals—a strongish furrow below the suture cuts off the top of the ribs as a row of nodules; the middles of the whorls are scored, especially in the intercostal furrows, with remote impressed lines, which are more or less obsolete; on the front of the base are 4 to 6 strongish, flat, subimbricated threads: coiling round the base of the pillar is a broad shallow furrow, in which the longitudinal ribs are visible; below this is a prominent thread, while the point of the pillar is scored by about 4 sharpish threads with broader furrows. *Colour* livid, with more or less of brown; the point of the pillar is white, as are two bands, one at the suture and the other above the periphery. *Spire* short, conical, subscalar. *Apex* small but blunt, the three smooth, rounded, globose embryonic whorls being somewhat depressed; they are also markedly smaller than the succeeding regular whorl. *Whorls* 9, conical, slightly convex, the last a little tumid. *Suture* impressed and slightly canaliculate. *Mouth* oval, pointed, channelled and nicked above, with a short oblique canal in front. *Outer lip* sinuated above, straight, and rather contracted to the point of the base, where it is patulous; it is toothed within, serrated on the anterior edge, right-angled at the canal, the edge of which is sharply margined by the infrabasal thread. *Inner lip* concave and toothed above, straight and bluntly tubercled on the pillar, the point of which is flanged, and down which the edge of the labial callus projects prominently, leaving a shallow chink behind it. *Operculum* thin, yellow, oval, triangular, with a slightly ser-

rated outer and inner edge. H. 0·8. B. 0·45. Penultimate whorl, 0·18. Mouth, height 0·33, breadth 0·24.

Mr. Marrat, of Liverpool, whose labours on the genus *Nassa* in particular are well known, and who has had the goodness carefully to examine the whole of the 'Challenger' species of the group, considers this species to be his *N. lævigata* (=*glabella*, Marr. nec Sow.), an opinion which I am not able to accept. With a considerable general resemblance, the form of the shell is very different. In *N. lævigata* the shortness and breadth of the last whorl gives a contour-line totally unlike that of *N. levukensis*, which is narrow at the periphery and comparatively long in the base. It has points of resemblance to *N. monile*, Kien., to *N. algida*, Reeve, to *N. coronata*, Lam., and to *N. crenulata*, Brug., but is certainly distinct from them all. It most of all resembles one of the depauperated forms of *N. canaliculata*, Lam., in some of which the canaliculation of the suture becomes very obsolete; but in none of these is there so sharp a flange round the anterior canal, none have so deep a furrow at the origin of the pillar, nor so sharp a thread in front of that furrow, and in all the apex has a broader base, and is higher, sharper, more conical. The operculum, too, is quite unlike, being in these very much smaller, more oval, and without serrated edges.

2. Nassa psila, n. sp. (ψιλὸς, rubbed.)

St. 185 b. August 31, 1874. Lat. 11° 38′ 15″ S., long. 143° 59′ 38″ W. Off Raine Island, Torres Straits. 155 fms. Sand and shells.

Shell.—Very thin, glassy, polished, white, with some brown stains; conical, scarcely oblique, with a high scalar spire, a small blunt apex, a short truncate base, a sharply flanged canal, and a very small snout. *Sculpture*. Longitudinals—the earlier whorls are crossed by numerous regular fine riblets parted by very similar furrows; they are straight, but incline a little obliquely to the left; they hardly increase in size, but on the last 1½ whorls become obsolete; the lines of growth are very fine. Spirals—below the suture is a narrow horizontal shelf, whose sharp edge is ornamented with an expressed row of blunt tubercles; these are formed by a deepish furrow isolating the tops of the ribs; narrow shallow furrows stipple the interstices of the riblets; these become faint on the last whorl, but increase in strength and become more continuous as they approach the outer lip; they also increase in strength towards the point of the base. *Colour* horny or translucent

glassy white, with some brown stains vaguely linear. *Spire* high, conical, scalar. *Apex* small, consisting of 3½ depressedly globose, glossy, keeled, embryonic whorls. *Whorls* 9 to 10, horizontally shouldered, angulated, cylindrical, with a short, rounded, and contracted base. *Suture* marginated and slightly constricted. *Mouth* round, sharply pointed above. *Outer lip* rounded on the edge and narrowly reverted, straight above, rounded at the base, more or less patulous throughout; the canal has a reverted, flanged margin. *Inner lip* convex on the body, concave in the middle, straight on the pillar; the labial glaze, which is very glassy, spreads broadly and undefinedly on the body, and projects with a narrow prominent edge down the pillar, which has a flanged and twisted point. H. 0·78. B. 0·39. Penultimate whorl, height 0·16. Mouth, height 0·38, breadth 0·22.

It is quite possible this may prove to be only a deep-water variety of that very variable species, *N. glans*, L.; but it so different that it is impossible to place it in that group, and, indeed, Mr. Marrat connects it with a different section altogether. There is no form which unites the polish and the exquisite sculpture of this species.

3. Nassa brychia, n. sp. (*βρυχιός*, belonging to the deep sea.)

St. VIII. Feb. 12, 1873. Lat. 28° 3′ 15″ N., long. 17° 27′ W. Off Gomera, Azores. 620 fms. Mud, shells.

Shell.—Strong, coarse, dirty white, ovate, rather stumpy, with a conical subscalar spire, a small blunt apex, a round truncated base, a very short pillar, and scarcely any snout. *Sculpture.* Longitudinals—the whorls are crossed by blunt, narrow, sparse, sinistrally oblique riblets, which continue to the snout; the last forms a strong varix on the edge of the lip; the lines of growth are fine, but towards the mouth become coarse. Spirals—below the suture is a slight shoulder formed by a row of coarse, depressed tubercles marking the upper end of the riblets; on the upper whorls there are 2 to 3, on the body about 5, coarse, shallow furrows parted by broadish flat bands; on the base there are 6 of these furrows with narrower bands; round the base of the pillar winds obliquely a shallow furrow, with a slight sharpish band in front; the short pillar is scored with the old contorted canal-scars. *Colour* a dirty porcellaneous yellowish white. *Spire* rather short, conical, subscalar. *Apex* blunt and rounded, consisting of 3½ smooth, depressedly turbinate whorls, of which the tip is very small. *Whorls* 9, conical, scarcely convex, not constricted below,

with a short rounded base. *Suture* marginated, and this margin tubercled. *Mouth* oval, open, bluntly pointed above. *Outer lip* sharp on the edge, sparsely toothed, patulous, almost straight, slightly advancing below, but not prominent on the base; the canal has a slightly reverted flange. *Inner lip* straight; on the body it is a little hollowed into the pillar, which is very short, and has in front a thickened (but not flanged) twisted edge; the pad of glaze is not thick, and has a sharply defined outer edge throughout its whole length. H. 0·65. B. 0·37. Penultimate whorl, height 0·14. Mouth, height 0·35, breadth 0·2.

This resembles *N. reticulata*, L., more than any other Atlantic form; but, besides being much smaller, the form of spire is much more scalar; the ribs and spiral threads are much fewer, and their intersections are flattened, not tubercled; the callus on the lip is not indefinitely spread on the body; the junction of the pillar and the body is not so deeply furrowed; and the front of the pillar has no threads, only scars. It somewhat approaches a variety of *N. trivittata*, Say; but that has a much more conical, less scalar spire, with more rounded whorls; the last whorl is much less broad, is higher, is more extended in front, and is covered with raised rounded threads.

Mr. Marrat, in his most curious and interesting study 'On the Varieties of the Shells of the Genus *Nassa*,' p. 52, puts this species into a group very remote from either of the above.

4. Nassa babylonica, n. sp.

St. 210. Jan. 25, 1875. Lat. 9° 26′ N., long. 123° 45′ E. Philippines. 375 fms. Mud. Bottom temperature 54°·1.

Shell.—Small, thin, porcellaneous, high and narrow, scalar, ribbed, with a sharp tubercle at the top of each rib, a small blunt apex, and a very short stumpy base. *Sculpture.* Longitudinals—there are rounded, rather high, narrow, straight, sparsely-set ribs, almost mucronate at the top of the whorls and tubercled on the base; the lines of growth are fine, close, and hair-like. Sp below the narrow, flat, horizontal shoulder are two or three threads, which rise into sharp points in crossing the ribs; in the middle of the whorls there are some faint traces of raised threads; those on the base are sharper, and rise into tubercles in crossing the ribs; all these, as well as the ribs, die out at the extreme point of the base; beyond this the pillar is defined by a strong broad furrow, and the short twisted pillar is scored with rounded

threads. *Colour* porcellaneous white. *Spire* high, scalar, conical. *Apex* a blunt little cone of 3¼ depressed rounded whorls, out of which the minute tip just rises into view; the last of these embryonic whorls is keeled. *Whorls* 9½, with a flat horizontal shoulder, from which the higher whorl rises like a cylindrical tower; at the outer edge of the shoulder the whorls are sharply angled; they are all very short; and the last, which is small, has a very truncate rounded base. *Suture* marginated and very flexuous in consequence of the tubercles on the margin. *Mouth* round, patulous, bluntly pointed above, prolonged across the front of the very short pillar into a little round hole of a canal. *Outer lip* well arched, retiring, with a rounded edge, and thickened both outside and in; on the internal varix there are in front a few small blunt tubercles; round the canal the edge is thickened, reverted, and emarginate. *Inner lip* straight across the body, concave in the middle, and straight on the very short pillar: the labial pad is rather narrow, thick, with a raised and rounded edge; it has a biggish tubercle near the top, and 3 or 4 others, smaller, on the body and pillar, the point of which is twisted and patulous, but not flanged. *Operculum* very small, triangular or claw-shaped, being long and narrow; the edges are not serrated. H. 0·45. B. 0·23. Penultimate whorl, height 0·1. Mouth, height 0·16, breadth 0·11.

I do not know with what to compare this curiously shaped species, in which the whorls, tubercled round the top, rise one above the other in terraces or small towers. There is a fossil species, *N. turbinelloides*, described and figured by Prof. Seguenza in his great work 'Le formazioni terziarie nella Provincia di Reggio,' p. 261, pl. xvi. fig. 23, which seems to resemble it more than any thing I know; but it is markedly different in the more elongated base. Mr. Marrat, in his 'Varieties of *Nassa*,' p. 59, no. 992, puts the 'Challenger' species between *N. plebecula*, Gould, and *N. luteola*, E. Sm.

5. NASSA AGAPETA, n. sp. (ἀγαπητὸς, beloved.)

July 29, 1874. Levuka, Fiji. 12 fms.

Shell.—Small, thin, translucent, ovate, with a short spire, a small, conical, rather abrupt apex, an impressed suture, a rounded, rather tumid base, and a largish snout. *Sculpture.* Longitudinals—there are smooth, rounded, narrow, sinuous ribs, parted by shallow rounded furrows of double their width; they originate in a row of largish tubercles close to the suture, are somewhat

irregularly continuous from whorl to whorl, and die out at the extreme point of the base; the last forms a large white varix a little remote from the lip-edge. Spirals—there is a continuous thread of largish tubercles close below the suture, with a strongish furrow on its underside; the interstices of the ribs are scored by narrow furrows and flat threads, which latter on the base rise into small tubercles in crossing the ribs: there is no special furrow round the base of the pillar, which is scored with fine close-set threads up to the sharp-topped swelling which is continuous with the canal; the small point beyond this swelling has 3 or 4 coarser irregular threads and furrows. *Colour* faintly yellow, with traces of a sutural, median, and basal band of brown. *Spire* stumpy, conical. *Apex* a short, broad, blunt cone of 3½ whorls, the two last of which are sharply keeled; the union-line of this embryo to the first regular whorl has a deep round sinus with a blunt brown-stained lip. *Whorls* 7, slightly convex, conical, beaded round the top; the last whorl is large compared with the others, is a little elongated, and has a rounded base produced into a snout, which is broadish and somewhat larger than is usual in the genus. *Suture* impressed. *Mouth* oval, pointed above, and continued below into the large oblique funnel-mouthed canal. *Outer lip* thin and sharp in front of the labral varix, straight above, arched and patulous below, with about 12 long little teeth within; it does not form a flange round the very patulous canal-mouth. *Inner lip* concave, with a broad, thick labial glaze, behind the prominent round edge of which is a minute chink; on this glaze there is one large long tooth near the upper corner of the mouth, some 2 or 3 small round tubercles on the body, and 4 larger ones on the very short pillar, whose point is flanged, twisted and very abruptly cut off. H. 0·24. B. 0·12. Penultimate whorl, 0·05. Mouth, height 0·13, breadth 0·07.

This dainty little species, with some very obvious superficial differences, closely approaches *N. pusio*, A. Ad.; but the embryonic whorl has half a whorl fewer, and the sculpture and form are really different. In particular, the pillar is not isolated by a strong basal furrow, and the spiral furrows on the base, though strong, have nothing like the depth they have in that species; nor has the pillar in that the little teeth which are very marked in the 'Challenger' species. Marrat in his monograph on the Varieties in *Nassa*, p. 97, no. 1337, places it between *N. splendidula*, Dunker, and *N. trinodosa*, E. Sm.

6. NASSA CAPILLARIS, n. sp.

St. 113 A. Sept. 1, 1873. Lat. 3° 47′ S., long. 32° 24′ 30″ W. Anchorage at Fernando Noronha. 25 fms.

Shell.—Rather small, thick, porcellaneous, stumpy, with rounded whorls, a conical subscalar spire, a short conical apex, a rounded, truncate, oblique base, and a short, very oblique snout defined by a strong furrow. *Sculpture.* Longitudinals—there are about 12 coarse rounded ribs and furrows; the last rib forms a strong varix behind the lip; these ribs are very feeble in the suture, and die out on the base; there are hair-like, sharp, close-set lines of growth. Spirals—on the penultimate whorl there are about 6 strongish rounded threads, above these and below the suture are two or three finer and weaker; those on the base are rather stronger than the others; the base of the pillar is defined by a strong furrow, with a sharp thread in front of it; the pillar is somewhat weakly scored by coarse flat spirals. *Colour* somewhat glossy white, with more or less of a rich chestnut band in the middle of the whorls, which colour is strongest in the interstices of the ribs. *Spire* rather high, conical, subscalar. *Apex* small, consisting of three turbinate rounded whorls. *Whorls* 10, short, subcylindrical, constricted at the top; the last is hunchy, very short, round, with a very oblique contracted base. *Suture* a little impressed, and slightly marginated in consequence of the comparative feebleness of the ribs immediately below. *Mouth* round, open, very bluntly pointed above, and produced below into the oblique, narrow, funnel-mouthed canal. *Outer lip* thickened outside and in by a white varix, of which the one inside is scored by 10 or 12 long, close-set, sharpish teeth; it is arched throughout, is very slightly retreating, and very patulous on the forward-arching base. *Inner lip* semicircular, with a thick white pad of glaze, which has a sharp, prominent and defined edge with a slight chink behind it; there is a strong blunt tooth above, several irregular and indefinite tubercles on the body, and four or five round and biggish tubercles on the very short pillar, whose twisted patulous and abruptly cut-off point is not flanged. H. 0·5. B. 0·25. Penultimate whorl, height 0·1. Mouth, height 0·21, breadth 0·17.

Mr. Marrat thinks I have mixed up two species here, he regards the largest specimen as *N. proxima*, C. B. Ad. (= *N. versicolor*, C. B. Ad., fide Carp.), a Panama species, and holds the rest as *N. incrassata*, Müller, a North-Atlantic and British species. Dr. Gwyn Jeffreys agrees with me in considering all the specimens

to belong to one species, and that *not N. incrassata*. Compared with *N. proxima* this species differs in being more contracted at the suture; the whorls are rounder and less flat, and lack the peculiar infrasutural contraction and flattening and the solitary strong remote thread which lies there; the spirals are stronger and more regular, while that species is nearly smooth; the embryonic apex is larger, its whorls being in that other species more minute, while they are at the same time depressed or immersed. The longitudinal ribs, too, in *N. proxima* are fewer and weaker the mouth is larger, more oval, more produced at the lower outer corner; the outer lip is thinner, with fewer, narrower, less regular teeth; the inner lip is much more widely spread out on the body; the pillar, too, is shorter. It has resemblances to *N. sanctæ helenæ*, A. Ad., to *N. cinctilla*, Gould, to *N. coccinella*, Lam., to *N. antillarum*, d'Orb., to *N. ambigua*, Pult., to *N. pygmæa*, Lam., to *N. nucleolus*, Phil., and to *N. acuta*, Say, with all of which this species has been very carefully and fully compared; but it is needless to detail the points of distinction. As regards *N. incrassata*, Müller, that very variable species has a very constant stain in the canal; seen from above, the whole canal and pillar are broader; the longitudinal ribs are more regular, and these, like the spirals, are stronger, being both rounder and higher; and they run flexuously indeed, but with a distinct trend from left to right, while in the 'Challenger' species the trend is from right to left. In Müller's species the apical whorls are more rounded, and are parted from each other by a deeper suture; the labial pad, too, is undefined.

7. NASSA EPHAMILLA, n. sp. (ἐφάμιλλος, a match for another, viz. *N. Woodwardi*, Forb.)

St. 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E. N.E. from New Zealand. 700 fms. Grey ooze. Bottom temperature 40°.

Shell.—Rather small, thin, chalkily porcellaneous, ovate, with a shortish scalar spire, a rounded apex, a marginated suture, whorls rounded and beset with small prickles, a tumid base and a very short pillar. *Sculpture.* Longitudinals—there are on each whorl about 20 narrow feeble ribs, which do not extend to the upper whorl and die out on the base; the lines of growth are fine, flexuous, and close-set. Spirals—there are on the penultimate whorl four broadish but very slightly raised threads; in crossing the longitudinal riblets these rise into small prickles, or pointed

tubercles; on the body-whorl there are 5 or 6 of these, and 4 or 5 more on the base, which latter are sharper, higher, and less tubercled; below the suture is a short, bare, more or less flat shoulder; round the base of the pillar is a small sharp spiral, which is continuous with the upper edge of the canal; the back of the pillar is scored with very undulating lines, the scars of the old canal. *Colour* chalky white. *Spire* rather short, more or less scalar, with a convex outline. *Apex* blunt and rounded, consisting of nearly 4 largish, smooth, turbinate, convex whorls, of which the highest is immersed. *Whorls* 7, stumpy, convexly cylindrical, flatly shouldered above; the last is tumid, with a very rounded, almost inflated, and short base, on which, looked at from behind, the point of the pillar is barely discernible, and the edge of the canal does not project at all. *Suture* impressed, flatly marginated below, very horizontal. *Mouth*: a perfect oval all round, having no angulation above, and though cut on the edge, yet being in its sweep quite uninterrupted by the canal in front. *Outer lip* thin, sharp, and patulous, very prominent but barely angulated at the point of the base in advance of the pillar; the canal is shallow and open, with a very reverted funnel-edge. *Inner lip* concave, with a thick, narrow, defined labial pad, running down the very short pillar, whose point is sharp and expanded, but not flanged. *Operculum* plain-edged, small, triangular, slightly subspiral, having its apex terminal and bent in towards the left. H. 0·57. B. 0·33. Penultimate whorl, height 0·14. Mouth, height 0·25, breadth 0·2.

Mr. Marrat considers this species "very closely allied to *N. Woodwardi*, Forbes" and from this fact I have derived its name. It is certainly liker that than any thing else I know, but is very markedly distinct. That species has a conical spire, a long, narrow, oblique body-whorl, with a short penultimate whorl, and a produced base, on which the pillar and canal-edge project prominently; the whorls are conical; the suture is not marginated so much by a bare shoulder below, as by a row of coarse blunt tubercles; its ribs and spirals are broad and square; and their intersection produces square and very blunt tubercles, of which there are about 30 in each whorl; the outer lip is thick and toothed, and the pillar is comparatively long. The absence of the crimson-brown bands of that species proves nothing; for these might quite naturally be absent in deep-sea specimens.

Buccinum spinulosum, Phil. (Enum. II. 191, xxvii. 13) seems

to have many points of resemblance. In shape as well as in sculpture it is very like; only both ribs and spirals are much stronger; the mouth, too, is oval, but it is pointed above and is longer below, *N. ephamilla* having a broader and more truncate base. My estimate on all these points, however, is based on Philippi's description and figure, the species itself being unknown to me.

Mollusca of H.M.S. 'Challenger' Expedition.—Part XIV.

By the Rev. Robert Boog Watson, B.A., F.R.S.E., F.L.S.

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[Read March 16, 1882.]

Fam. Muricidæ, *Flem.*

Gen. Fusus, *Lam.* | Gen. Trophon, *de Montf.*

In the following group are several interesting forms, especially some of the *Siphos* and *Trophons*; but of them all, probably the most remarkable is one which, for the present, I have called *Fusus* (*Colus*) *pagodoïdes*. I have no doubt that in the long run it, with the two species of *Fusus* which here precede it, and many of the *Trophons* will be classed with the *Fusus pagoda*, Less., and the *Pleurotoma spinicincta*, v. Mart., for which last Prof. v. Martens has lately proposed a subgenus (*Columbarium*), based chiefly on the radula. Of this organ Mr. G. Schacko describes and figures two very curious teeth, which were the only ones he was able to obtain from the dried-up specimen in his hands. If I have not adopted Prof. v. Martens's classification here, it is because his paper reached me only a very few days ago, and time has not sufficed to consider the matter in all its bearings.

Gen. Fusus, *Lam.*

Subgen. Metula, *H. & A. Ad.*
Sipho (*Klein*), *Mörch.*

1. *Fusus* (*Metula*) *philippinarum*, n. sp.
2. *F.* (*Sipho*) ——, n. sp.
3. *F.* (*S.*) *pyrrhostoma*, n. sp.
4. *F.* (*S.*) *calathiscus*, n. sp.
5. *F.* (*S.*) *setosus*, n. sp.
6. *F.* (*S.*) *scalaris*, n. sp.
7. *F.* (*S.*) *regulus*, n. sp.

Subgen. Neptuna, *Bolten.*
Colus, *Gray.*

8. *Fusus* (*Sipho*) *edwardiensis*, n. sp.
9. *F.* (*Neptunea*) *Dalli*, n. sp.
10. *F.* (*N.*) *futile*, n. sp.
11. *F.* (*Colus*) *radialis*, n. sp.
12. *F.* (*C.*) *sarissophorus*, n. sp.
13. *F.* (*C.*) *pagodoïdes*, n. sp.

1. FUSUS (METULA) PHILIPPINARUM, n. sp.

St. 210. Jan. 25, 1875. Lat. 9° 26′ N., long. 123° 45′ E. Philippines. 375 fms. Mud. Bottom temperature 54°·1 F.

Shell.—Strong, porcellaneous, pale ruddy brown, fusiform, long, subscalar, with feeble ribs and with spiral threads; the whorls are slightly angulated; the mouth long, with a slight emargination above, and an open triangular canal in front. *Sculpture.* Longitudinals—there are on the upper whorls about 15 small, sharpish, straight, bluntly mucronated ribs, which are feeble on the shoulder beneath the suture, but stronger below; on the later whorls these are less distinct and more oblique, becoming flexuous on the base; these correspond exactly with the delicate crimpings of the lines of growth. Spirals—the whole surface is covered with fine, regular, and equal narrow threads and broader furrows; of these, on the penultimate whorl there are about 15, the centre one of which is thrown into prominence by a slight angulation, very marked on the earlier but feeble on the later whorls. *Colour* pale ruddy brown, with a flinty pellucidness, especially toward the apex, and more of whiteness toward the point of the snout. *Spire* high, conical, subscalar. *Apex* contracting abruptly to a small raised point, formed by about three smooth rounded embryonic whorls, which are not sharply distinguished from those which follow, the regular sculpture making its appearance gradually. *Whorls* 8 in all; the upper ones have a sloping shoulder, are angulated in the middle, and are cylindrical or slightly contracted below; the last is more rounded, and is produced into a long and pointed base ending in a triangular conical snout. *Suture* slightly channelled. *Mouth* long and pear-shaped. *Outer lip* thickened internally with a strongish white varix, between which and the sharp patulous edge the spiral threads of the exterior sculpture are just visible; it is very slightly emarginated above near the body, and well arched throughout, till along the canal, where it is straight but oblique. *Inner lip* straight across the body, hollow in the middle, and straight but unusually oblique down the whole pillar, which is not in the least twisted: a thin layer of glaze narrowly spreads along its whole length. *Operculum* thin, subtriangular, pointed behind, and bluntly so in front at the apex, which is subterminal, but slightly coiled in to the inner side. H. 0·9. B. 0·39. Penultimate whorl, height 0·16. Mouth, height 0·52, breadth 0·2.

This specimen is classed as a *Metula* with considerable doubt:

the outer lip is not thickened externally, nor distinctly toothed internally; but these features are perhaps due to the shell not being quite full-grown; the mouth, too, is a little broad for the genus. The operculum of *Metula* is unknown to me; but Adams's figure of the operculum of *Cantharus* is in form very similar (only that in the 'Challenger' species the apex is a little more turned in subspirally), and Troschel confirms Adams's classification here, and puts the two genera in closest collocation. The shell has some faint resemblance to *Pisania reticulata*, A. Ad.

2. FUSUS (SIPHO) ——, n. sp.?

St. 47. May 7, 1873. Lat. 41° 15′ N., long. 65° 45′ W. Off Halifax. 1340 fms. Mud.

The four specimens of this species are in bad condition, being dead, broken, and not full-grown. It resembles *F. cinereus*, Say (see Binney, Gould's Invert. Mass. p. 370, fig. 637), = *Buccinum plicosum*, Menke (see Philippi, Abbild. &c. I. p. 109, pl. xxvi. fig. 8); but its longitudinal ribs are more numerous, and, instead of being convex to the right as in that species, they are convex to the left. The corresponding whorls here are smaller; and it has no approach to an umbilicus. It has also some resemblance to *B. obsoletum*, Say, = *Nassa noveboracensis*, Wood, Index, p. 214, Suppl. pl. iv. fig. 26, but is very obviously different.

3. FUSUS (SIPHO) PYRRHOSTOMA, n. sp.

St. 141. Dec. 17, 1873. Lat. 34° 41′ S., long. 18° 36′ E. 20 miles S.S.E. of Cape of Good Hope. 98 fms. Sand and mud. Bottom temperature 49°·5 F.

Shell.—Fusiform, with a shortish base, a high spire, and a bent mamillary apex; ribbed, and with rather fine spiral threads; light brown and thin. *Sculpture*. Longitudinals—each whorl is crossed by about 15 concave, sinuous, narrow, and little-raised ribs, which on the last whorl die out on the base. The fine hair-like lines of growth correspond with the curves of the ribs. Spirals—below the suture there is a slightly constricted area, as in the Pleurotomidæ; below this is a very blunt indistinct carination. The whole surface is covered with slight rounded spiral threads, which are markedly stronger and wider parted on the base and snout. *Colour* a ruddy brownish yellow, with a very thin, hard, smooth, persistent epidermis. *Spire* high, conical. *Apex* bent, cylindrical, the first and second whorls being nearly of a size, and both rather swoln. *Whorls* 7, convex, slightly constricted

above, very faintly and obtusely angulated above the middle, and contracted below; the last is slightly ventricose, with a rounded base, produced into a very lop-sided triangular snout. *Suture* small but distinct, being slightly impressed. *Mouth* crescentic, pointed above, and prolonged below into a short oblique canal. *Outer lip* thin and sharp, slightly sinuated above, rounded and prominent in the middle, and retreating along the canal. *Inner lip* flat above, concave at the base of the pillar, which is straight, longish, conical, and obliquely cut off in front: a thinnish, narrow, sharply-defined pad of glaze extends along the whole length of the lip. *Operculum* subtriangular, with the apex at the lower inner point, thin but strong, brownish yellow. H. 1·55. B. 0·6. Penultimate whorl, height 0·28. Mouth, height 0·78 breadth 0·33.

This species greatly resembles *Fusus* (*Sipho*) *Kröyeri*, Möller; but is smaller, and has a contraction below the suture absent in that, the whorls are less tumid, the longitudinal ribs are much smaller and less curved; the lines of growth correspond with the ribs instead of cutting obliquely across them; the spiral sculpture, too, is more raised and less regular. The apex in the 'Challenger' specimen is somewhat eroded, but is distinctly more cylindrical, the first and second whorls being much more nearly equal than in Möller's species.

4. FUSUS (SIPHO) CALATHISCUS, n. sp.

St. 147. Dec. 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E. Off Marion Island and the Crozets. 1600 fms. *Globigerina*-ooze. Bottom temperature 32°·2 F.

Shell.—Thin, white, tumid, fusiform, with a high scalar spire, and a rounded base prolonged into a short, small-pointed, lop-sided snout. *Sculpture.* Longitudinals—there are very many close-set lines of growth; the surface of the thin membranaceous epidermis is very finely and sharply wrinkled, so as to project in very fine lamellæ. Spirals—there are on the upper whorls 7 to 8 narrow, rounded threads, parted by wider furrows which are very shallow. The spirals become feebler and sparser on the last whorl, with fainter threads in the intervals. *Colour* porcellaneous white under the pale yellowish-white epidermis. *Spire* high, blunt, scalar. *Apex* eroded. *Whorls* about 6, well rounded, slightly flattened at the top, and a little contracted toward the bottom; the last is rather tumid. *Suture* strong and impressed.

the outer lip is not thickened externally, nor distinctly toothed internally; but these features are perhaps due to the shell not being quite full-grown; the mouth, too, is a little broad for the genus. The operculum of *Metula* is unknown to me; but Adams's figure of the operculum of *Cantharus* is in form very similar (only that in the 'Challenger' species the apex is a little more turned in subspirally), and Troschel confirms Adams's classification here, and puts the two genera in closest collocation. The shell has some faint resemblance to *Pisania reticulata*, A. Ad.

2. FUSUS (SIPHO) ——, n. sp.?

St. 47. May 7, 1873. Lat. 41° 15′ N., long. 65° 45′ W. Off Halifax. 1340 fms. Mud.

The four specimens of this species are in bad condition, being dead, broken, and not full-grown. It resembles *F. cinereus*, Say (see Binney, Gould's Invert. Mass. p. 370, fig. 637), = *Buccinum plicosum*, Menke (see Philippi, Abbild. &c. I. p. 109, pl. xxvi. fig. 8); but its longitudinal ribs are more numerous, and, instead of being convex to the right as in that species, they are convex to the left. The corresponding whorls here are smaller; and it has no approach to an umbilicus. It has also some resemblance to *B. obsoletum*, Say, = *Nassa noveboracensis*, Wood, Index, p. 214, Suppl. pl. iv. fig. 26, but is very obviously different.

3. FUSUS (SIPHO) PYRRHOSTOMA, n. sp.

St. 141. Dec. 17, 1873. Lat. 34° 41′ S., long. 18° 36′ E. 20 miles S.S.E. of Cape of Good Hope. 98 fms. Sand and mud. Bottom temperature 49°·5 F.

Shell.—Fusiform, with a shortish base, a high spire, and a bent mamillary apex; ribbed, and with rather fine spiral threads; light brown and thin. *Sculpture.* Longitudinals—each whorl is crossed by about 15 concave, sinuous, narrow, and little-raised ribs, which on the last whorl die out on the base. The fine hair-like lines of growth correspond with the curves of the ribs. Spirals—below the suture there is a slightly constricted area, as in the Pleurotomidæ; below this is a very blunt indistinct carination. The whole surface is covered with slight rounded spiral threads, which are markedly stronger and wider parted on the base and snout. *Colour* a ruddy brownish yellow, with a very thin, hard, smooth, persistent epidermis. *Spire* high, conical. *Apex* bent, cylindrical, the first and second whorls being nearly of a size, and both rather swoln. *Whorls* 7, convex, slightly constricted

above, very faintly and obtusely angulated above the middle, and contracted below; the last is slightly ventricose, with a rounded base, produced into a very lop-sided triangular snout. *Suture* small but distinct, being slightly impressed. *Mouth* crescentic, pointed above, and prolonged below into a short oblique canal. *Outer lip* thin and sharp, slightly sinuated above, rounded and prominent in the middle, and retreating along the canal. *Inner lip* flat above, concave at the base of the pillar, which is straight, longish, conical, and obliquely cut off in front: a thinnish, narrow, sharply-defined pad of glaze extends along the whole length of the lip. *Operculum* subtriangular, with the apex at the lower inner point, thin but strong, brownish yellow. H. 1·55. B. 0·6. Penultimate whorl, height 0·28. Mouth, height 0·78 breadth 0·33.

This species greatly resembles *Fusus* (*Sipho*) *Kröyeri*, Möller; but is smaller, and has a contraction below the suture absent in that, the whorls are less tumid, the longitudinal ribs are much smaller and less curved; the lines of growth correspond with the ribs instead of cutting obliquely across them; the spiral sculpture, too, is more raised and less regular. The apex in the 'Challenger' specimen is somewhat eroded, but is distinctly more cylindrical, the first and second whorls being much more nearly equal than in Möller's species.

4. Fusus (Sipho) calathiscus, n. sp.

St. 147. Dec. 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E. Off Marion Island and the Crozets. 1600 fms. *Globigerina*-ooze. Bottom temperature 32°·2 F.

Shell.—Thin, white, tumid, fusiform, with a high scalar spire, and a rounded base prolonged into a short, small-pointed, lop-sided snout. *Sculpture.* Longitudinals—there are very many close-set lines of growth; the surface of the thin membranaceous epidermis is very finely and sharply wrinkled, so as to project in very fine lamellæ. Spirals—there are on the upper whorls 7 to 8 narrow, rounded threads, parted by wider furrows which are very shallow. The spirals become feebler and sparser on the last whorl, with fainter threads in the intervals. *Colour* porcellaneous white under the pale yellowish-white epidermis. *Spire* high, blunt, scalar. *Apex* eroded. *Whorls* about 6, well rounded, slightly flattened at the top, and a little contracted toward the bottom; the last is rather tumid. *Suture* strong and impressed.

Mouth oval, rounded above, pointed at the canal, which is very short, wide, and a little oblique. *Outer lip* thin, well rounded, patulous and straight along the canal. *Inner lip* concave from the top of the mouth to the point of the pillar, which is straight, short, rather narrow, and obliquely cut off in front. A very thin glaze runs across the body and down the pillar. *Operculum* thin, pale yellow, with very regular curves of growth arching from side to side; in form it resembles a long narrow wedge with a terminal apex. H. 1·25. B. 0·7. Penultimate whorl, height 0·3. Mouth height 0·77, breadth 0·4.

This species strongly resembles *Buccinopsis canaliculata*, Dall, of which he kindly sent me a specimen from Behring's Straits. It has, in particular, the deeply impressed or canaliculated suture of that form; but it is much thinner, has higher and more tumid whorls, with much finer sculpture, and it has not the lanuginous epidermis of that species.

5. Fusus (Sipho) setosus, n. sp.

St. 146. Dec. 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E. Off Marion Island. 1375 fms. *Globigerina*-ooze. Bottom temperature 35°·6.

St. 147. Dec. 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E. Off Marion Island and the Crozets. 1600 fms. *Globigerina*-ooze. Bottom temperature 34°·2.

Shell.—Thin, white, setose, with longitudinal and spiral threads, fusiform, with a scalar spire, and a rounded base produced into a short, prominent, lop-sided snout. *Sculpture.* Longitudinals—there are on the upper whorls many, very regular, rounded threads, which become fainter on the later whorls; besides these, the epidermis is closely wrinkled in minute sharp lamellæ. Spirals—there are on the upper whorls 5 to 6 rounded threads parted by wider interstices; these are of about the same strength as the longitudinals; and their intersection forms a very regular lattice-work, with a short stiff bristle at their crossing-points; on the last whorl these bristles are crowded close together so as to be contiguous. *Colour* porcellaneous white under the greyish-yellow epidermis. *Spire* high, blunt, scalar. *Apex* eroded. *Whorls* about 6, well rounded, slightly flattened at the top, and constricted below; the last is rather tumid. *Suture* strong and impressed. *Mouth* rounded above, with a slight angle at the top, and a short open canal below that runs out obliquely across the point of the pillar. *Outer lip*

thin, well rounded, straight and patulous along the canal. *Inner lip* concave, with a very short direct pillar, which is obliquely cut off and twisted in front; a very thin narrow glaze lies on body and pillar. H. 1·1. B. 0·6. Penultimate whorl, height 0·22. Mouth, height 0·44, breadth 0·33.

It is very possible this and the preceding may be the same species, and may be ultimately united to *Buccinopsis canaliculata*, Dall; but the differences in form and in epidermis make their separation inevitable till a fuller series of specimens perhaps supply links of connection.

6. Fusus (Sipho) scalaris, n. sp.

St. 305 a. Jan. 1, 1876. Lat. 47° 48′ 30″ S., long. 70° 47′ W. N.W. Patagonia. 125 fms. Mud.

Shell.—Small, thin, porcellaneous white, with feeble longitudinals and faint spirals, a high, conical, scalar spire, small mamillary apex, a short, rounded, contracted base, and a small, lop-sided, slightly reverted, emarginate snout. *Sculpture.* Longitudinals—there are about 15 rounded, slightly tumid ribs, which originate below the upper suture, and hardly reach the lower, and on the base die out; they are parted by broad, rounded, shallow furrows; the surface is all scored with sharp unequal lines of growth. Spirals—near the top of the whorls is a blunt angulation; above this obsoletely, and below it not very strongly, the surface is scored by broad, flatly rounded threads parted by narrow, very slightly depressed furrows; these threads and furrows do not appear on the snout. *Colour* porcellaneous white. *Spire* high, conical and scalar. *Apex* small, mamillate, with a very small, slightly depressed tip; it consists of about two smooth, rounded embryonic whorls. *Whorls* 7, with a high, slightly declining, and rounded shoulder, defined by a blunt angulation, below which the whorls are somewhat cylindrically conical, contracting slightly into the lower whorl. *Suture* impressed, but rounded and open, the lower whorl lapping up on the upper, and the true suture being linear. *Mouth* oval, bluntly pointed above, and produced below into the short, open, oblique canal. *Outer lip* a little receding above on the shoulder, bluntly angulated at the keel, below which point it is arched, with a very slight constriction at the short, open, and slightly reverted snout. *Inner lip* very slightly concave above, straight on the short pillar, and oblique along the canal, where there is a twist on the point of the pillar; it is bordered by a narrow thin glaze, which runs out almost to the extreme point of

the shell. H. 0·5. B. 0·22. Penultimate whorl, height 0·1. Mouth, height 0·23, breadth 0·12.

The generic place of this and the three following species is very doubtful; but the mouth is rather too wide to justify their being classed with the *Pyrene* group of *Columbella*, which the general aspect of the shell suggests as their place.

7. FUSUS (SIPHO) REGULUS, n. sp.

St. 149 D. Jan. 20, 1874. Lat. 49° 28′ S., long. 70° 13′ E. Royal Sound, Kerguelen. 28 fms. Mud.

Shell.—Small, thin, porcellaneous white, with fine riblets and delicate spirals, a rather high, subscalar spire, a large blunt mamillary apex, deep suture, small body, a short rounded contracted base, and a small, lop-sided, emarginate snout. *Sculpture.* Longitudinals—there are on the last whorl about 25 narrow, sharply raised, flexuous, little ribs, parted by flat furrows of twice their breadth; these decrease in number up the spire; they die out toward the point of the base; they bend quickly to the left below the suture, advancing to the right lower down: the furrows and snout are scored with fine lines of growth. Spirals—there are feeble, rounded, sparsely-set threads, of which about eight on the penultimate whorl; immediately below the suture they are very faint, but are present. *Colour* yellowish porcellaneous white. *Spire* high, rather cylindrically conical. *Apex* blunt, mamillary, with an exceedingly small impressed tip; it consists of two globose, smooth, embryonic whorls. *Whorls* 5½ to 6 in all, with a rounded shoulder defined by a very slight angulation, below which the whorls are subcylindrical; the last is scarcely tumid, with a rounded contracted base prolonged into a stumpy, slightly reverted, emarginate snout. *Suture* sharp, impressed, rather deep, horizontal. *Mouth* oval, slightly angulated above, and produced below into a short, broad, open, and somewhat oblique canal *Outer lip* thin, a little expanded, arched, advancing below, contracted at the canal; there is at the top a faint approach to a sinus. *Inner lip* concave above, straight on the pillar, which is in front little oblique, but has a slight twist; a thin narrow glaze defines it throughout. H. 0·28. B. 0·13. Penultimate whorl, height 0·08. Mouth, height 0·14, breadth 0·09.

This species has some faint resemblance to *Columbella* (*Pyrene*) *costulata*, Cantr., but is less compact, has a more impressed suture and more rounded whorls, wants the densely set minute spirals, and has a longer snout; the apex, too, differs from that species,

in which the tip rises in a minute point, while here it is impressed.

8. Fusus (Sipho) edwardiensis, n. sp.

St. 145. Dec. 27, 1873. Lat. 46° 43′ S., long. 38° 4′ 30′ E. Between Marion Island and Prince Edward Island. 140 fms. Grey sand.

Shell.—Small, thin, porcellaneous white, feebly ribbed and faintly spiralled, with high spire, blunt apex, rounded whorls, a short contracted base, and a small snout. *Sculpture.* There are on the penultimate whorl over 20 rounded, oblique, and rather straight riblets, parted by similar, rounded furrows; these are obsolete on the last whorl, and are much fewer in number higher up the spire: the lines of growth are very fine. Spirals—the surface is covered with very faint, rounded, close-set threads. *Colour* porcellaneous white with a dead surface. *Spire* high, conical, subscalar. *Apex* blunt, rounded, mamillary, with an immersed tip; it consists of two smooth, globose, embryonic whorls. *Whorls* 5½; they are suddenly contracted above into the suture, below this they are convexly cylindrical, with a very slight contraction at the bottom; the last is a very little tumid, with a rounded conical base produced into a very short, lop-sided, emarginate snout. *Suture* rather deep and sharp. *Mouth* oval, hardly angulated above, and produced below into the short, oblique, open canal. *Outer lip* well arched; there is a feeble sinus near the suture, and a slight prominence in front. *Inner lip* concave above, straight on the pillar, the point of which is twisted and obliquely truncate; it is defined by a thin narrow glaze. H. 0·25. B. 0·11. Penultimate whorl, height 0·06. Mouth, height 0·12. breadth 0·05.

The half-grown shells of *Columbella* (*P.*) *Holbölli*, Möller, which often present feeble riblets, have some faint resemblance to this species, but these have a much sharper apex and a less impressed suture.

9. Fusus (Neptunea) Dalli, n. sp.

St. 173. July 24, 1874. Lat. 19° 9′ S., long. 179° 41′ E. Off Matuka, Fiji. 315 fms. Coral.

Shell.—Thin, porcellaneous, pale ruddyish yellow, fusiform, long, finely ribbed and spiralled, with compressed and constricted whorls and a club-shaped mouth. *Sculpture.* Longitudinals—the whorls are crossed by narrow little ribs and furrows, of which

there are about 11 on the upper whorls and 19–20 on the penultimate, becoming increasingly feeble as they approach the mouth; they harmonize completely with the course of the dense, clear, and sharp hair-like lines of growth. Spirals—there are narrow, prominent spiral threads, of which two near the bottom of the whorls are somewhat stronger than the others; the furrow which parts them is also a little wider and deeper than the rest; below this is a small but rather sudden constriction of the whorls into the suture; the spirals in crossing the longitudinal ribs are thrown out into blunt white linear points; the spirals on the base and snout are more regular and equal than the others. *Colour* a pale ruddyish yellow, with a fine roughened surface. *Spire* high and conical. *Apex* broken, but apparently very small, sharp, and smooth. *Whorls*, 8 remain; probably the broken embryonic apex consisted of two more; they are convex, with a slight slow contraction above and a small sudden constriction below; the last is small, long, with rounded outlines, and produced into a long, rather lop-sided and slightly twisted snout. *Suture* fine, sharp, impressed. *Mouth* long, club-shaped, being oblong, pointed above and produced in front into a longish canal. *Outer lip* thin, with a slight, white, internal varix, not much arched, patulous in front, where its line is concave, and then straight along the canal. *Inner lip* short and scarcely convex on the body, hollowed at the base of the pillar, which is narrow, straight, and cut off in front, on a long, slightly oblique, and somewhat twisted line; the glazing which edges it is very thin and narrow. H. 1·27. B. 0·5. Penultimate whorl, height 0·2. Mouth, height 0·7, breadth 0·24.

The general aspect of this shell is very much that of a *Fasciolaria*; but the pillar has no plaits. It is not in form unlike the young of *F. rostratus*, Olivi; but the base is much longer, and the snout shorter, and the constriction at the bottom of the whorls is not found in that species; in these respects it has more resemblance to *F. syracusanus*, Lam., in which, however, the whole sculpture is very unlike. It resembles perhaps most of all *F. filosus*, A. Ad., from the Chinese seas, but is still slimmer in its outlines.

I have called this species after my friend Mr. W. H. Dall, of the Smithsonian Museum, Washington, who has give me much good counsel and valuable information.

10. FUSUS (NEPTUNEA) FUTILE, n. sp.

St. 150. Feb. 2, 1874. Lat. 52° 4′ S., long. 71° 22′ E. Between Kerguelen and Heard Islands. 150 fms. Rock. Bottom temperature 35°·2.

Shell.—Thin, pale, fusiform, long, very bluntly ribbed and with equal spiral threads; the whorls are rounded, the suture rather deep and oblique, the mouth club-shaped, the pillar small and somewhat twisted. *Sculpture.* In the middle of the whorls are low rounded riblets, which extend to neither suture; they are parted by shallow rounded furrows broader than the ribs; the surface is scored with strongish hair-like lines of growth. Spirals —there are clear well-rounded threads, about 9 on the penultimate, and fewer on each preceding whorl; on the last whorl they are not so equal as on the others, being somewhat stronger in the middle of the whorl; they are parted by squarish shallow furrows. *Colour* pale greyish white; but the specimen is bleached. *Spire* high and conical. *Apex* small, smooth, rounded and slightly depressed. *Whorls* 7, of slow increase, rounded, contracted above, slightly so below; the last is small, rounded on the base, and prolonged into a small and somewhat twisted snout. *Suture* oblique, impressed, minutely channelled. *Mouth* club-shaped, being oval above, and produced into a longish canal below. *Outer lip* much broken. *Inner lip*: there is a very narrow thin glaze on the body and pillar, of which the point is bent upwards and twisted. H. 0·74. B. 0·3. Penultimate whorl, height 0·15. Mouth, height 0·36, breadth 0·17.

This species has some resemblance to the young of *F.* (*N.*) *lachesis*, Mörch, but has the apex much smaller, is in form more conical, has the suture more oblique, possesses longitudinal ribs, and has the spirals stronger. Compared with *F.* (*N.*) *latericeus*, Möll., the apex is much smaller, the whorls are of much slower increase, are more rounded, and are more contracted above, the suture is deeper and more oblique, the ribs are weaker, the spirals are stronger, and the snout is longer and more twisted than in that species. Compared with *F.* (*N.*) *undulata*, Friele (which I only know by the admirable plate, kindly sent me by the author), this *F. futile* is smaller in the apex, less cylindrical and more conical, the whorls are less rounded, and difference in breadth below and above is much greater; the suture, too, is much less impressed and more oblique.

11. Fusus (Colus) radialis, n. sp.

St. 142. Dec. 18, 1873. Lat. 35° 4′ S., long. 18° 37′ E. Off the Cape of Good Hope. 150 fms. Sand. Bottom temperature 47° F.

Shell.—Thin, fusiform, high, narrow, with rounded whorls bisected by a sharp radiatingly tubercled keel, and parted by a deep open suture; the rounded and contracted base is produced into a long narrow snout. *Sculpture.* Longitudinals—the surface is scored by sharp, high, close-set, unequal, hair-like lines of growth. Spirals—in the middle of each whorl is a sharp expressed keel running out into rays of horizontal blunt tubercles *; above this there are two rounded threads, and below it one, parted by flat furrows three times their breadth; on the last whorl below the keel there are of these threads, on the base three, at the root of the snout one, and on the snout about ten. The whole surface is further scratched with fine sharp lines. *Colour*: the specimen is dead and bleached. *Spire* scalar, high and conical. *Apex* eroded. *Whorls* 6 to 7, well rounded but for the prominent sharp keel which angulates them; they are very much contracted above and markedly so below; the last is a little tumid, with a round much contracted base, produced into a long, straight, narrow snout. *Suture* a minute line at the bottom of the deep broad hollow in which the superior and inferior whorls meet. *Mouth* irregularly circular, and produced into a long, straight, narrow canal. *Outer lip* thin. *Inner lip* shortly concave above, and then very straight. H. 1·47. B. 0·62. Penultimate whorl, height 0·2. Mouth, height 0·87, breadth 0·3.

This species, the only specimen of which is unfortunately in very bad condition, slightly resembles *F. spiralis*, A. Ad., but is broader, the suture is deeper, the upper part of the whorls is much more sculptured, and the keel is much sharper and more expressed.

12. Fusus (Colus) sarissophorus †, n. sp.

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Thin, porcellaneous, white, acutely, substellately carinated, with a short, conical, subscalar spire, mamillate apex, deep suture, contracted base, and long, sharp, and fine snout. *Sculp-*

* Hence the name.

† So called from the long pike-like snout which it bears.

ture. Longitudinals—fine hair-like lines of growth closely cover the surface. Spirals—near the bottom of each whorl there is a very sharply expressed but not narrow keel, which is closely beset on the edge with rounded compressed little tubercles; the whole surface of the whorls is scored with fine rounded threads and broader furrows, which are more delicate above than below the keel; these become obsolete toward the point of the snout. *Colour* porcellaneous white. *Spire* short and conical. *Apex* mamillate, but small; it consists of nearly two glossy, keelless, cylindrical whorls, of which the extreme tip is flattened down on one side. *Whorls* 7, sharply angulate and biconical, being contracted above and below. *Suture* deep and sharp. *Mouth* clavate, being oval above and produced below into a very long and minute canal. *Outer lip* sharp, rounded, pinched in at the origin of the canal, down the side of which the line runs straight, and parallel to the pillar. *Inner lip* slightly hollowed above and very straight in front; it is defined by a very thin and narrow glaze. H. 0·77. B. 0·28. Penultimate whorl, height 0·08. Mouth, height 0·55, breadth 0·11.

This very beautiful little shell is probably not full-grown, but possesses very marked features in the short conical spire, sharp stellate keel, and enormously long snout. The only form which seems to approach it is the *Fusus spiralis*, Ad., which has a curious geminately carinated and flattened form of whorls and a long canal; but the keel is median, the suture wide and deep, and the apex is broad and blunt, while the spire is much less broadly conical.

13. Fusus (Colus) pagodoïdes *, n. sp.

St. 164 b. June 13, 1874. Lat. 34° 13′ S., long. 151° 38′ E. Off Sydney. 410 fms. Grey ooze.

Shell.—Rather thin, chalky to porcellaneous, pale, oval, with a high scalar spire made up of small sharp-flanged whorls, with a mamillate apex and a very long fine snout, down which from the round mouth runs a thread-like cleft. *Sculpture.* The surface is scored with extremely sinuous fine lines of growth formed by the subimbricated edges of scarcely raised lamellæ. Spirals—in the middle of each whorl is a sharp keel, which runs out into an excessively sharp, prominent, compressed, and up-turned flange; though so sharp and compressed, this flange is really double, and

* So called from its likeness to *F. pagoda*, Less.

consists of a multitude of very minute hollow arches, imbricated on one another. On the base of the body-whorl, coincident with the upper corner of the mouth, is a small cord-like keel closely beset with minute arched points. The upper third to half of the snout is obliquely scored with remote raised threads rising into high, sharp, arched scales. There are a few faint microscopic spiral scratches. *Colour* a dead, faintly yellowish, semiporcellaneous white. *Spire* high and conical. *Apex* smooth, small, but very blunt and mamillate, consisting of little more than one embryonic whorl, which is turned up on end, bent right over and spread out on the next, in which the characteristic keel appears almost immediately. *Whorls* 7, small, of very slow increase, excessively keeled, with a hollowed shoulder above, rounded and constricted below; the last is contracted very much to the middle of the base, which is produced into a very long and very narrow, slightly flexuous, conical snout. *Suture* small but distinct, and sharp, in the bottom of the wide constriction between the keels. *Mouth* angularly rounded, running out into a small canal at the keel, and prolonged below into the long, narrow, sinuous slit of the front canal. *Outer lip* thin, roundly arched, sharply cut by the carinal canal, and again on the base by a little canal on the basal thread; it is very much pinched-in in front, and then runs down straight along the edge of the slit of the front canal. *Inner lip* rounded at the very top; it then runs straight to the point of the pillar; somewhat thickened above; it joins the outer lip, and stands out prominently from the body, with a deep cleft behind it; it is continued down the whole pillar, standing out as a sharp thin lamina. *Operculum* large for the aperture, thin, yellow, roundedly triangular, with a terminal apex, and scored across with many fine curved lines of increase, altogether much like that of many of the Pleurotomidæ. H. 2·18. B. 0·9. Penultimate whorl, height 0·19. Mouth, height 1·72 (aperture 0·34, canal 1·38), breadth 0·3.

I have described this as a distinct species in obedience to the advice of all competent judges who have been consulted; but my own belief remains unaltered that it is a mere variety of *F. pagoda*, Less. Than that, this is a smaller shell, with a shorter spire; its carinal crown is a continuous flange, not a series of hollow flat spikes, the whorls are higher between keel and suture, the base is more contracted and compressed, the prickles on the spiral threads of base and snout are much closer, sharper, and

higher, the canal in front is much narrower; finally, Lesson's species has *two* embryonic whorls, and these stand up much higher than in this.

The Rev. J. E. Tenison Woods, in a very interesting paper (read before the Royal Society of N. S. Wales, July 4, 1877, and of which he obligingly sent me a copy) on the Tertiary deposits of Australia, p. 8, refers to a fossil *Fusus* occurring in the lowest clays of the Australian Tertiary deposits of lower Miocene, or perhaps Eocene, age. Of this *Fusus* he says that "it is so like the beautiful and delicately spined *F. pagodus* of the Philippines, that it has I believe been named *F. pagodoïdes* by Prof. M'Coy." I have not been able to ascertain that this spcies has ever been published, and having already, before Mr. Woods's paper reached me, selected this name for the 'Challenger' species, I have thought it better to retain it, the more so that, should the Australian fossil prove to be the same as the species living in deep water off Sydney, the substitution of another name would be a pity and would tend to create confusion.

Since writing the above, and just as this paper is leaving my hands, I have received from Prof. v. Martens with his accustomed kindness the number of his 'Conchologische Mittheilungen' (vol. II. pts. 1 & 2), issued for December 1881, containing his beautifully illustrated description of *Fusus pagoda*, Lesson (p. 106, pl. xxi. f. 4.), which he attaches to a new subgenus of *Pleurotoma* under the name of *Columbarium*, enriching the group with a new species *P. (C.) spinicincta* (p. 105, pl. xxi. f. 1–3), got by the German war-vessel 'Gazelle' in 76 fathoms, from (apparently) a spot some 500 miles N. by E., on the same east coast of Australia from which the 'Challenger' specimens come. At p. 122, Mr. G. Schacko (pl. xxiv. f. 1, 2) gives details of the radula, on the peculiarities of which the subgenus is mainly based. The opinion of Prof. v. Martens is of course of commanding weight; and if I have not followed him here, it is merely because I see that not *F. pagodoïdes* alone, but many of the forms grouped under *Trophon* will have to share the fate of *F. pagoda*, Less., whatever that may ultimately be.

In the meantime I content myself with calling attention to this increase in the number of those forms which gather round Lesson's remarkable and beautiful species. With this increase in their number, however, there comes no link of connexion between them; for not one of the three species helps to unite the

other two, though the 'Challenger' species stands on the whole nearer to Lesson's than v. Martens's species does to either. *P.* (*C.*) *spinicincta*, v. Mart., is distinguished by its high conical spire, its small apex, its more numerous carinal spines, its double basal keel, and the sparseness of the muricated threads on its snout.

TROPHON, *de Montfort*.

1. *T. acanthodes*, n. sp.	4. *T. aculeatus*, n. sp.
2. *T. carduelis*, n. sp.	5. *T. septus*, n. sp.
3. *T. declinans*, n. sp.	6. *T. scolopax*, n. sp.

1. TROPHON ACANTHODES, n. sp. (ἀκανθώδης, prickly.)

St. 308. Jan. 5, 1876. Lat. 50° 8′ 30″ S., long. 74° 41′ W. W. Patagonia. 125 fms. Mud.

Shell.—Strongish, chalkily porcellaneous, yellowish, fusiform, with a high scalar spire, small apex, sharply keeled and radiatingly spiked whorls, a rounded contracted base, and a long, narrow, but strong snout. *Sculpture.* Longitudinals—the surface is scored with close, very irregular lines formed by the slightly raised edges of thin imbricated procumbent lamellæ, between which there are almost microscopic scratches in the lines of growth; there are 8 or 9 feeble oblique riblets on the lower part of the whorls; these die out on the base. Spirals—toward the upper part of each whorl there is an acute angulation with an expressed rounded keel, from which projects a coronal of longish rays or pointed, up-turned, retroverted vaulted spikes, each of which forms the origin of one of the longitudinal riblets; below this keel there are feeble, irregular, rounded threads, which may be recognized on the snout. The whole surface is covered with very fine, close-set rounded threadlets. *Colour* yellowish, with a singularly harsh surface. *Spire* high, scalar. *Apex* mamillate, but small, consisting of nearly three smooth, cylindrical, embryonic whorls, of which the extreme tip is slightly immersed. *Whorls* 7 to 8, flat above, sharply angulated, keeled and coronated, conically contracted to the lower suture; they are all small, but the last, which is a little tumid, with a rounded base, very much contracted and produced into a long, straight, spike-like snout. *Suture* sharp and deep, in the bottom of the broad depression between the keels. *Mouth* club-shaped, being rather small and oval above, and contracted below into the long, narrow, but patulous canal. *Outer lip* roundly arched, angulated at the keel, where

the vaulted spikes present a canal; it is patulous below and down the whole anterior canal. *Inner lip* rounded above, where it expands on the body, joining the outer lip without any angulation; at the top of the canal it projects in a slight blunt tooth; from this point it becomes much narrower, and only the excessively narrow edge of the glaze can be recognized, almost hiding behind the long straight pillar. H. 1·5. B. (exclusive of the spines) 0·64. Penultimate whorl, height 0·22. Mouth, height 1, breadth 0·32.

This species resembles *T. vaginatus*, Jan, but is much more tumid on the base, is more constricted at the anterior canal, has a straighter snout, a less contracted suture, and a lower spire.

2. Trophon carduelis *, n. sp.

St. 164 B. June 13, 1873. Lat. 34° 13′ S., long. 151° 38′ E. Off Sydney. 410 fms. Grey ooze.

Shell.—Thin, porcellaneous white, fusiform, with a high scalar spire, very small apex, long, small snout, angulated whorls, scored by thin, sharp, procumbent lamellæ rising on the keel into high vaulted spikes. *Sculpture.* Longitudinals—there are on each whorl 9 or 10 thin, sharp, vaulted, and procumbent lamellæ, the old lip-edges; they are pretty prominent, cross the whole whorls, are obliquely continuous from whorl to whorl, rise on the upper part of the whorls into hollow, vaulted, upturned, and reverted spikes, and are traceable to the point of the snout; between these lamellæ are slight lines of growth. Spirals—above the middle of each whorl there is an angulation, the effect of which is greatly increased by the coronal of spikes which project at this point; one or two very depressed rounded threads, parted by minute linear furrows, are also found on this angulation; similar but feebler and very irregular threads and furrows cover the rest of the surface. *Colour* porcellaneous white, with a smooth but not polished surface. *Spire* high, scalar. *Apex* small, consisting of two smooth rounded, globose, embryonic whorls, the extreme tip of which is very small and is slightly turned over and immersed. *Whorls* about 10, flatly sloping above, angulated and coronated, conically contracted to the lower suture; they are all small but the last, which is slightly tumid, with a rounded and shortly produced base pro-

* I have failed to approach the idea of "thistly" nearer than by this, the name of the Thistle-Finch, which really ought to have had the same latitude as its Greek equivalent ἀκανθίς. The prickles on this species of *Trophon* recall strongly those of the involucre of some thistles.

longed into a projecting, narrow, slightly reverted snout, which is a little bent at the point. *Suture* small and sharp, interrupted by the lamellæ, but very strongly marked by the deep constriction of the whorls. *Mouth* club-shaped, being oval above and produced into the long narrow canal. *Outer lip* sharp and thin, leaves the body at a right angle, advances straight to the keel, where a patulous canal is formed in the spike; below this the lip is extremely patulous, and well arched to the origin of the canal, where the lip is sharply pinched-in, and from this point runs direct, but a little obliquely, to the point of the snout, where it is squarely cut off. *Inner lip* is a little concave above, straight on the pillar, slightly oblique down the canal; it is defined on the body and pillar by a thin, narrow, patulous pad; this pad crosses the pillar, and runs into the canal, along the side of which it shows only a thin sharp edge, with a small chink behind it. *Operculum* thin, yellow, ovate, acute, with a terminal apex, and corrugations and striæ in the curves of growth. H. 1·27. B. (spines included) 0·8, (excluded) 0·5. Penultimate whorl, height 0·19. Mouth, height 0·8, breadth 0·31.

This is a species beautiful in form and in texture. With some superficial resemblance, it differs from *T. acanthodes*, Wats., in its continuous longitudinal lamellæ, the thinness of its shell, the delicacy of its surface-texture, and the form of the base. In the latter respects it recalls *T. vaginatus*, Jan; but, than that species, it is less carinated, has a more contracted shorter base, a finer snout, and the spines are much more distinctly connected with the continuous lamellæ. *T. coronatus*, H. & A. Ad., a New-Zealand form, and which extremely resembles *T. Goodridgii*, For., has a much longer canal, a more tumid body, more numerous varices, with shorter spines not rising, as here, in a coronal round the spire. *T. laciniatus*, Martyn, from Vancouver's Island, presents a variety slightly resembling the 'Challenger' species; but the snout is much shorter, the base more produced; the spines, too, are very much shorter, and, rising near the suture, project upwards parallel to the spire.

3. Trophon declinans, n. sp.

St. 144 A. Dec. 26, 1873. Lat. 46° 48′ S., long. 37° 39′ 30″ E. Off Marion Island. 100 fms. (?) Grey sand.

St. 150. Feb. 2, 1873. Lat. 52° 4′ S., long. 71° 22′ E. Between Kerguelen and Heard Islands. 150 fms. Rock. Bottom temperature 35°·2.

Shell.—Thin, chalky white with a tinge of buff, fusiform, with a high subscalar spire, small mamillary apex, long small snout, rounded whorls scored by thin procumbent lamellæ. *Sculpture.* Longitudinals—there are on the later whorls from 15 to 20 procumbent lamellæ, between these are slight lines of growth. Spirals—there are a few quite irregular and obsolete rounded threads. *Colour* chalky white with a tinge of buff. *Spire* high, subscalar. *Apex* small, consisting of barely two smooth, globose, embryonic whorls, of which the extreme tip is slightly turned down on one side and immersed. *Whorls* 7, slightly flattened above, convexly cylindrical below, with a very slight contraction above the suture; the last is a little tumid, with a produced conical base running out into a long, small, twisted, and upturned snout. *Suture* slightly impressed, oblique. *Mouth* oval, bluntly pointed above, drawn out into the long, narrow, and oblique canal in front. *Outer lip* thin, arched, slightly reverted and patulous; very obliquely cut off and emarginated at the point of the canal. *Inner lip* very concave above, convex at the entrance to the canal, from which it runs with a twist and very obliquely to the left; the labial glaze is thin and somewhat indefinite. H. 0·8. B. 0·32. Penultimate whorl, height 0·17. Mouth, height 0·43, breadth 0·2.

I have described this as a new species with very great reluctance. My own opinion is that it is a large thin variety of *T. truncatus*, Ström; and that opinion is shared by Mr. E. A. Smith. Dr. Gwyn Jeffreys, however, and Prof. G. O. Sars decidedly hold it as distinct; and their extensive acquaintance with the large northern variety of *T. truncatus* makes their judgment of great weight. Along with the specimen of this species which I submitted to Prof. Sars I forwarded another shell, sadly broken, which I consider different and new, and have named *T. auditus*, from St. 150, and which I sent thinking it might be his *T. clavatus*. Prof. Sars's own letter will best convey his opinion regarding both of these forms:—"I have examined your shells very closely; they show a very perplexing similarity in form and sculpture to northern Trophons. . . . . The one specimen is certainly very nearly related to *T. truncatus*, Ström; but still I find, on comparing it with Norwegian specimens of the species, some differences. Thus the shell, though larger, is less solid, and the longitudinal ribs are also somewhat different both in number and in form; in all my specimens of *T. truncatus* they are distinctly lamellar and

reflexed; but in your specimen they have more the appearance of simple sharp folds or keels*. The other specimen somewhat resembles my *T. clavatus*—thus far at least, that the ribs are produced in similar tooth-like protuberances; but the ribs are more numerous, the spire somewhat more elongated, and the form of the "*cauda*" cannot be ascertained. After all, I must consider your specimens distinct from Northern forms. But, on the other hand, I should not be unwilling to regard both specimens as belonging to one species, and thus mere varieties analogous to the forms *T. clathratus* and *Gunneri*. Your specimens from Kerguelen are in any case very interesting as representing, even if not in my opinion an identical, yet at least a very similar and strictly representative form of *Trophon* belonging to the Southern hemisphere."

4. Trophon aculeatus, n. sp.

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Small, thin, porcellaneous white, fusiform, with a high scalar spire, a blunt, mamillate, one-sided apex, a short conical base, a long small snout, and angulated whorls crossed by continous thin, vaulted lamellæ, projecting on the angulation of the whorls into small sharp points. *Sculpture.* Longitudinals—there are on each whorl about 12 vaulted lamellæ, which run continuously from below the apex to the snout; between these are a few fine lines of growth. Spirals—an angulation, strongly marked by the projecting points of the longitudinal lamellæ, is in the middle of the whorls. *Colour* porcellaneous white. *Spire* high, scalar. *Apex* small, blunt, mamillate, with the extreme tip very much turned down on one side; the $1\frac{3}{4}$ embryonic whorls are tumid, rounded, and smooth. *Whorls* 6 to 7, with a straight declining shoulder, angulated in the middle and conically contracted below; the conical base is produced into a narrow longish snout. *Suture* deep and angular. *Mouth* club-shaped, being angulated above, and produced into the long narrow canal below. *Outer lip* sharp, thin, and patulous on the edge; it leaves the body at a right angle, and is right-angled at the keel. *Inner lip* is slightly concave above, straight on the very short pillar, and oblique down the edge of the long canal; a thin narrow glaze lies

* I do not admit the distinction which Prof. Sars here makes. I consider the longitudinal ribs in *T. declinans* to be quite as certainly procumbent lamellæ; only this feature is somewhat obscured by their being much chipped.—R. B. W.

on the edge of the body and pillar, at the point of which it crosses and lies hidden behind the sharp canal-edge. H. 0·45. B. 0·2. Penultimate whorl, height 0·08. Mouth, height 0·28, breadth 0·09.

This pretty little species perhaps resembles *T. barvicensis*, Johnston, more than any other, but, besides being more attenuated, is markedly differentiated by the median angulation of the whorls and the absence of the spiral threads of that species.

5. TROPHON SEPTUS, n. sp.

St. 149 D. Jan. 20, 1874. Lat. 49° 28′ S., long. 70° 13′ E. Royal Sound, Kerguelen. 28 fms. Mud.

Shell.—Thin, porcellaneous white, club-shaped, with a low scalar spire, blunt apex, high-shouldered sharply expressly and spinously keeled whorls, a tumid body, and a long thin flexuous snout. *Sculpture.* Longitudinals—the whorls are scored by feeble lamellæ and by coarsish lines of growth. Spirals—at the top of each whorl, but separated from the suture by a broad tabulation, is a right-angled keel, from which, nearly parallel to the axis of the shell, project a series of hollow, vaulted, compressed triangular spines; besides this coronal there is no other spiral sculpture except some irregular lines on the base. *Colour* porcellaneous white, with some chalkiness on the surface. *Apex* rather small, mamillate, and a little turned down on one side. *Whorls* 5 or 6, flatly tabulated above, with a rectangular keel, below which they are cylindrical; the last is a little tumid on the base, which contracts rapidly and is drawn out into a long, thin, flexuous snout. *Suture* almost rectangular. *Mouth* round, with a blunt angle at the top and a siphon at the keel, and suddenly prolonged into the narrow canal. *Outer lip* sharp, thin, direct, well arched, not prominent. *Inner lip* is concave above, slightly oblique on the very short pillar, and much more so on the long, bent, and slightly reverted snout; a thin narrow glaze defines it to the point of the pillar, where it crosses to the canal, leaving a minute chink on its outer edge above. *Operculum* thin, yellow, oval, with a blunt apex, where the nucleus is terminal. H. 0·91. B. 0·43. Penultimate whorl, height 0·1. Mouth, height 0·67, breadth 0·16.

The upturned coronal of hollow spines and the more contracted base differentiate this from *T. Goodridgii*, Forbes. It has some faint resemblance to the *Pleurotoma cedo-nulli*, Reeve.

6. TROPHON SCOLOPAX, n. sp.

St. 150. Feb. 2, 1874. Lat. 52° 4′ S., long. 71° 22′ E. Between Kerguelen and Heard Islands. 150 fms. Rock. Bottom temperature 35°·2.

Shell.—Thin, chalkily porcellaneous white, club-shaped, with a low, scalar, small-pointed spire, high-shouldered, right-angled whorls on which are some small prickles, a tumid body, and a long, thin, straight snout. *Sculpture.* Longitudinals—the whorls are crossed by feeble, procumbent, almost appressed lamellæ, between which are a few rounded lines of growth. Spirals—near the top of each whorl, but separated from the suture by a broad, rounded, but hardly declining shoulder, is a rectangular keel; below this, and widely apart, there are on the body-whorl three feeble rounded threads; on these, as on the keel, the longitudinal lamellæ rise into small, blunt, vaulted scales. The whole surface of the shell is covered with submicroscopic scratches. *Colour* porcellaneous under a thin chalky surface. *Apex* small, but too much eroded for description. *Whorls* 6 to 7 (?), roundly tabulated above, with a subrectangular keel, below which they are cylindrical; the last is a little tumid, rounded and rapidly contracted on the base, which is produced into a long, thin, straight snout. *Suture* almost rectangular. *Mouth* almost round above, and entirely without angles, funnel-shaped below, where it is drawn out into the long narrow canal. *Outer lip* sharp, thin, well arched, direct till near the canal, where it is very patulous. *Inner lip* concave above, and then quite straight to the point of the shell; a very thin and narrow glaze covers the body to the beginning of the canal. *Operculum* small, thin, yellow, oval, with a terminal but slightly inturned nucleus. H. 0·95. B. 0·42. Penultimate whorl, height 0·12. Mouth, height 0·7, breadth 0·2.

I have named this species from some likeness it has to a Woodcock's head. It resembles *T. Goodridgii*, Forbes, but has the body smaller and squarer, the base more contracted, the canal much longer and finer, and the whorls are tabulated below the suture. It is larger than *T. septus*, the snout is straighter, and the whole ornamentation is different.

Remarks on the Structure and Habits of the Coral-reef Annelid, *Palolo viridis*. By the Rev. THOMAS POWELL, F.L.S., of Upolu, Samoa.

[Abstract, read March 2, 1882.]

THE palolo* vary in length from 1 to 20 inches, and are in diameter from $\frac{1}{10}$ to $\frac{1}{4}$ of an inch. They are of four colours—white, light brown or ochre, greyish indigo, and dark green.

Those of the two former colours are males, and amongst these the darker-coloured varieties are of much greater length, and are also far more abundant than the white or cream-coloured ones. The greyish-indigo and dark-green varieties are females; and of these the dark-green are similarly far longer in measurement and far more abundant than the others.

Whilst watching the living animals under the microscope, I have noticed that the setæ move up and down and backwards and forwards with great rapidity, so as almost to recall to one's mind the motion of the cilia of a rotifer. I observed that this motion was attended by the rapid liberation of the eggs of the female and the sperm of the male, through oviducts and seminal ducts which extend on each side from the centre of the back, between each pair of somites, and terminate on the underside between each pair of lateral appendages. I observed that these ducts are smaller in the male than in the female.

The notion that, in order to effect the liberation of the eggs and of the sperm, the animals break up into small pieces is probably incorrect; for I saw under the microscope, as above narrated, the copious emission of the ova through the oviducts without any breaking-up into parts of the parent annelid. Moreover, on the very last occasion, viz. October 1880, when I had an opportunity of visiting the palolo-ground, I saw great numbers of very long both light and dark palolo (*i. e.* males and females) almost destitute of sperm and ova. These, when caught, broke up into small cyst-like segments, from which the greater part of the contents had apparently already been discharged. Furthermore, when considerable quantities of the worms have been brought to my house in a vessel, and kept a day or two, they have emitted large quantities of eggs and sperm, and yet have not broken up into small portions. That they should be broken up into small portions on the fishing-ground is not to be wondered at, seeing that the sieves are constantly plying. At

* See Trans. Linn. Soc. vol. xxii. p. 237, pl. xli.

the time of spawning the sea becomes discoloured with the eggs for a long way around; and yet there is no corresponding appearance of broken cysts: there are some such cysts to be seen, but nothing comparable to what there should be on the supposition which I am challenging.

That the sight of these annelids is perfect is evident from the way in which a single specimen will endeavour to escape the sieve with which it is the custom to catch them. Often, when seeing a fine single specimen approaching, I have put down my sieve, hoping to take it, but generally in vain; for no sooner has my sieve been put into the water, than the animal has made off rapidly in an opposite direction; and when I have attempted to intercept its flight, it has immediately dodged again and escaped.

The palolo move through the water in different ways: sometimes they are extended nearly at their full length, with but little curvature of their bodies; their progress is then slow. At other times they assume a more serpentine form of progression, and then move more rapidly, and it is by this method of movement that they seek to escape the sieve. In rising from the bottom to the surface, they assume a more spiral form.

The tail of the palolo is furnished with a disk, or with the power of forming itself into one. When examining some specimens under the microscope, in 1876, I observed one fix itself by a circular disk to the plate upon which I had placed it. It remained fast for some little time. On my touching it, it let go its hold and wriggled about; but it soon attached itself again, as before. The circular disk was very conspicuous when thus fixed, but was imperceptible when the animal was free. This power of attachment explains how these worms can remain so long as they generally do concealed among the coral. It may also suggest an explanation of the phenomenon recorded in the 'Samoa Times' of 16th April, 1881, viz. that, on the previous 21st of March, large quantities had appeared on the reef near the village of Gagaemalae, on Savaii—the appearance at such a time, instead of during the month of October, having never before been observed by the oldest inhabitants. The explanation may be this: some unusual local occurrence affecting the reef may have detached the worms from their holding-places, and caused their untimely appearance.

The worms have never been known to appear either at the immediate end of September or beginning of October. No doubt they adhere to the coral, in situations in which they cannot be

seen, till the time of spawning. When the season for this process arrives, they ascend to the surface of the water, inside the lagoon, near the outer reef, often in prodigious numbers; and the natives flock in their canoes, just before daylight, to catch them by dipping them up in sieves of various kinds. (See an interesting account of the scene on such occasions in Seemann's 'Mission to Viti,' pp. 59–61.)

The time of their appearance is the day of the last quartering of the moon in each October, *unless* that fall at the beginning of the month, in which case there will intervene another lunar month. This indicates that the moon exercises some mysterious influence on their reproduction. This, however, is not without analogy in nature, especially in reference to the Crustacea *e. g.*;—it is recorded in Hood's 'Cruise of the Fawn,' p. 127, that in Savaii, "three days before the arrival of the palolo, the malio or land-crabs (*Gecarcinus*) are seen marching down from the mountains to the sea in myriads."

The observations of many years, made by many old European inhabitants as well as by the natives, show that, if from the time of spawning in October we reckon 354 or 355 days, that will bring us to another spawning, unless such reckoning terminate at the end of September or the beginning of October, say from the 1st to the 4th day. In that case the reckoning must extend to 383 or 384 days, when the palolo will appear. Thus, instead of an interval of only twelve lunar months, one of thirteen will occur.

The Rev. G. J. Whitmee has shown, in a paper published in the 'Proceedings of the Zoological Society,' June 1875, that it is probable that this longer interval occurs every third year. The period appears to agree not so much with "solar time," as with the Metonic cycle "of the moon, of 19 years or 235 months, in which time the lunations return (nearly) and begin as they were before."

The natives are generally correct in their calculations as to the time of the appearance of palolo. They take, as the first indication of the approach of the season, the appearance of the scarlet flowers (called Aloalo) of the Gatae (*Erythrina indica*). Then, as a nearer approach, the general budding of the trees, and especially the flowering of the Tavai (*Rhus taitensis*), of the Lagaali (*Aglia edulis*, Asa Gray), and of the Seasea (*Eugenia*, sp.). When this last is in bloom, the men look out for the moon's being just above the western horizon at the dawn of day, and on the

tenth morning from that they look for the appearance of the palolo; but the extra lunar month sometimes puts them wrong. Others watch with equal success, for the indication of the season, the sinking below the horizon of various constellations, commencing with Orion.

I should mention that there is a second appearance of palolo each year, occurring a month after the first, consisting of such worms, probably, as were not sufficiently mature to spawn in October—or, it may be, of another species.

The palolo is by no means confined to Samoa and Viti. Our Samoan missionaries in the Gilbert Group have informed me that they also are found at those atolls. One of the missionaries caught some of both the grey and green varieties there. The worms are found near the outer reefs, in from 4 to 8 feet of water. The natives of the Gilbert Islands hold that the palolo is a production of the coral—grows out of it; they call it "Te Nmatamata," *i.e.* the Glistener. It appears there in *June* and *July*. How is this? Why there in June, but here in October? Perhaps it may be because those atolls are nearly on the line, while Samoa is 14° more to the south.

Samoa, May 14th, 1881.

P.S.—If the above calculations and statements are correct, the palolo should appear in Samoa on October 15th or 16th, 1881, October 5th or 6th, 1882, and October 25th or 26th, 1883.

Observations on British Salmones.—I. Trout.

By Francis Day, F.L.S.

[Read March 16, 1882.]

At the early part of 1880 I exhibited some Salmonidæ before the Linnean Society*, in order to demonstrate how local causes may induce temporary or even permanent changes among members belonging to this family of fishes. The first example I showed was an American charr (*Salmo fontinalis*). The specimen was nine inches in length, of good condition, and with brilliant colours; it had been reared by the late Mr. Frank Buckland in his tanks at the Horticultural Gardens, South Kensington, from eggs received direct from Lake Huron. He presented some of the fry to the authorities of the Westminster Aquarium soon after that institution was first opened; and the example under consideration was the last survivor, having met with its death in October 1879, when

* For brief notice of which see the 'Proceedings' of the Meeting 5th February 1880, p. lii.

it was kindly sent to me by Mr. Carrington, F.L.S., the naturalist in charge. Here no question respecting the parentage of the fish could arise, no crossing with European trout could have occurred; but a single glance at the specimen sufficed to show great differences from what may be considered to be its normal form. The head had much elongated in proportion to the length of its body; and the very form of the subopercle had changed, being twice as long as deep, instead of nearly square, as observed in this species when in a state of nature. I had also two other examples of this fish reared from eggs derived from the same source; they were turned out in Cardiganshire in 1876, and captured in the middle of 1877: in them the head was not elongated, and the form of the subopercle was normal. It appeared to me that these facts were very suggestive: certain unnatural conditions had caused unnatural changes of certain parts; and it did not appear improbable that, were other examples similarly reared, they might in like manner differ from the primitive stock. Neither could I see why, if such forms were transferred to ponds or streams, they should not retain such abnormal variations through succeeding generations or return to what normally existed among their ancestors.

I also showed four examples of young salmon (*Salmo salar*) reared by Mr. Frank Buckland from eggs received from Huningen, and which were collected from salmon captured for this purpose from below the falls of Schaffhausen. As year after year passed by, and these fish were still retained in the comparatively small amount of fresh water which was sufficient to fill the tanks in the Horticultural Gardens, the same results developed themselves which have usually attended the retaining of salmon parr in freshwater ponds. The lanky half-starved body became identical with that of *Salmo gracilis*, Couch, and *S. argenteus**, Günther. As this subject has been well treated of by Dr. Murie†, I do not propose considering it further at this time.

Since the period (1880) first alluded to, I have received extensive collections of Salmonidæ, more especially from Sir Pryse Pryse, of Gogerden, Cardiganshire, a beautiful variety‡ obtained for me in Yorkshire by Mr. G. Brooks, F.L.S., Loch-Leven trout from our late Secretary, Mr. E. R. Alston, examples from Waterford and elsewhere; while I have visited the Eastern counties, the museums of the North and Scotland, personally captured examples

* Drawing exhibited. ‡ Figure exhibited.

† Proc. Zool. Soc. 1868, p. 247, pl. xxiii, and 1870, p. 30, pl. ii.

in Gloucestershire and in Cornwall (*S. cornubiensis*), irrespective of investigating the beautiful series in the British Museum.

The various forms indigenous to this country, and usually considered as pertaining to the genus *Salmo*, have been thus divided:—

(1) *Trutta*, Nilsson; *Salmo* and *Fario*, Cuvier. Salmon.

Anadromous forms, possessing at some period of their lives deciduous teeth on the vomer, which teeth are usually shed commencing from behind forwards.

(2) *Salar*, Cuvier. Trout.

Freshwater non-migratory forms, possessing at some period of their lives teeth on the vomer which are to a certain extent deciduous, the shedding of which commences from before backwards.

(3) *Salvelini*, Nilsson. Charr.

Freshwater non-migratory forms, in which the vomerine teeth are restricted to the head of that bone.

The remarks which I have to make will refer to the second group or subgenus of the genus *Salmo*, or *Fario*, our freshwater non-migratory trout, respecting which I will commence by observing that (excluding the Loch-Leven trout) we have only one form, the *S. fario*, Linn.,—*S. ferox*, Jardine & Selby, *S. nigripinnis*, Günther, *S. stomachicus*, Günther, *S. gallivensis*, Günther, and *S. orcadensis*, Günther, being simply varieties which, due to local circumstances, have developed certain changes, some of which appear at first sight to be permanent, others to be transitory.

If we examine into the history of these fishes as given by our various British authors, we find as follows:—

Donovan, in his 'British Fishes' (1802–1808), refers to the common trout (*Salmo fario*), which he observed was subject to many varieties, differing in appearance according to the season of the year and also the nature of the water it inhabited. He commented on a *form* existing at Llyndivi, a lake in South Wales, where it was termed "Coch y dail" (it was marked with black spots as large as sixpences); to a crooked-tailed variety in the Eynion, a river not far from Machynlleth, as well as to its being found in the Snowdon lakes; to the Gillaroo trout of Ireland, remarkable for the great thickness of its stomach, though it does not differ in other respects from the common trout; and, lastly, to some in the Scotch lakes that are very differently *coloured externally* from the common sort, and which he suspected might be a distinct species. He next alluded to the variation of trout

in *size*,—referring to the Fordwich form in Kent, which attains nearly to the weight of salmon; to the Buddaghs of Lough Neagh, in Ireland, some of which weighed nearly 30 lb. He finally drew attention to the *colour internally*, or that of the flesh, remarking upon having taken both the red and the white kind at the same season in two contiguous streams in Cardiganshire, one of which invariably produced the red and the other the white variety.

Turton admitted into the 'British Fauna,' 1807, the common trout and the parr. Fleming, in his 'History of British Animals,' recognized the same, remarking of the Gillaroo variety that when it feeds on shellfish the coats of its stomach acquire a thickness causing it to resemble the gizzard of birds. Jenyns, in his 'Manual of British Vertebrate Animals,' 1835, recorded the common trout with its variety the Gillaroo; the great lake-trout, *S. ferox*, which he believed to be identical with the *S. lacustris* of Berkenhout. Yarrell ('History of British Fishes,' 1836) at first admitted the parr or samlet, the common trout, and great lake-trout, and, in a later edition, the Loch-Leven trout. Parnell, in 1838, in his prize essay on the Fishes of the Firth of Forth, gave the same as Yarrell did. Jardine, in his 'British Salmonidæ,' figured the great lake-trout, the common trout, and varieties. Thompson ('Natural History of Ireland,' 1856) gives the common trout, including the Gillaroo, which variety he recorded having met with in most freshwater races, and the great lake-trout. White, in the 'List of the Specimens of British Animals in the British Museum' (1851), enumerated the common trout and the great lake-trout.

In 1865–66 Dr. Günther bestowed a large amount of research upon this family of fishes, and brought together a beautiful collection of specimens in the British Museum; and if I am unable to agree with his conclusions, it must be remembered that the Tasmanian experiment, so fatal to the validity of his reputed species, did not commence until subsequent to the publication of vol. vi. of the 'Catalogue of the Fishes in the British Museum.' In it, in 1866, he described the following forms:—*Salmo levenensis*: vertebræ 57 to 59, cæcal appendages 49 to 90*. *Salmo fario*, var. *fario*: vert. 59–60, cæc. pyl. 33–46; var. *ausonii*: vert. 57–58, cæc. pyl. 38–47. *Salmo ferox*: vert. 56–57, cæc. pyl. 43–49.

* These numbers are distinctly recorded in the pages of the sixth volume of the 'Catalogue of the Fishes in the British Museum,' by Dr. Günther, as existing in specimens present in the collection of that institution.

Salmo stomachicus: vert. 59–60, cæc. pyl. 44. *Salmo gallivensis*: vert. 59, cæc. pyl. 44. *Salmo orcadensis*: vert. 56–57, cæc. pyl. 50. *Salmo nigripinnis*: vert. 57–59, cæc. pyl. 36–42. The foregoing show an extreme range as follows:—*S. levenensis*, vertebræ 57–59, cæcal appendages 49–90; the remaining six, enumerated as species, vertebræ 56–60, cæcal appendages 33–50. In the year 1880, Wallace, 'Island Life' (p. 321), on the authority of Dr. Günther, introduced these forms as distinct species, observing, "They are in fact, as Dr. Günther assures me, just as good and distinct species as any other recognized species of fish;" while Dr. Günther, 'Introduction to the Study of Fishes' (p. 644) reiterates, with but slight variations, his conclusions come to in 1866. Thus, as in the former work he observed "that at least some of the species interbreed, and it is probable, although at present not confirmed by direct observation, that such hybrids mix again with one of the parent species, thereby producing an offspring more or less similar to the pure breed" (Catal. vi. p. 3), he asserts in his later work that "some of the species interbreed, and the hybrids mix again with one of the parent breed, thus producing an offspring more or less similar to the pure breed" (Introd. Stud. Fish. 1880, p. 631). This exceedingly interesting conclusion, unfortunately, is unsupported by reference to the results of any experiments or observations made by competent individuals, leaving one in doubt as to whether it is an opinion founded upon conjecture or fact.

From our very earliest authors on ichthyology down to the present period, the existence of hybrid fishes has been insisted upon; and of late years artificial propagation has clearly proved that such can occur; but it is open to grave doubt whether among the Salmonidæ they are as numerous in a wild state as some authors would have us believe; while, so far as my inquiries tend, the fertility of hybrids still remains to be proved *. Experiments have been instituted to test this question of hybrids; and Professor Rasch, in 1867, recorded the result of his investigations. He found that the ova of the sea- and river-trout are developed regularly whichever form were the parent, and the offspring are fertile; that, of the ova of the charr fertilized by the milt of the trout, 30 to 40 per cent. are developed, but many young fish perish after being hatched; trout-ova fertilized by the milt of the charr gave only 10 per cent. developed, and many of the young were misshapen; salmon-ova fertilized with trout-

* Professor Rasch refers to the ova of a hybrid between a trout and a charr.

milt yielded 40 per cent. of young fish, but none if the milt of the charr were used; that the ova of a hybrid between a trout and a charr could not be fertilized with trout milt. I saw at Berlin lovely hybrids between trout and charr, but was unable to obtain satisfactory evidence that such were fertile forms.

I will now briefly record the results which I have arrived at in testing the interesting conclusions, given in Dr. Günther's 'Catalogue,' as to what constitutes a species of trout. I took first what are termed *constant characters*, as the number of the vertebræ as well as of the cæcal appendages, as they appeared to be considered among the most important factors in affording a guide to specific differences. I obtained leave from Mr. Elwes to use his trout-preserves at Colesbourne, on the summit of the Cotteswold Hills, where no new races of trout have been introduced, and consequently the original local form remains unchanged. According to Dr. Günther's investigations, the variety of brook-trout termed *S. fario*, distributed in the northern parts of Europe and Scotland (Catal. vi. p. 59), has vertebræ 59–60 and cæca pylorica 33–46; whereas the variety *Ausonii* is stated to possess vertebræ 57–58 and cæca pylorica 38–47. The latter "is found in Central Europe and the southern parts of England" (vi. p. 59). Certain varieties of distribution are alluded to; and it is asserted that the northern form "extends as far southward as Shropshire, where both forms are met with." I captured a considerable number of trout at Colesbourne, which from its locality should have produced the variety *Ausonii*, and found that they had the number of vertebræ stated to belong to that form, or 57–58, but that their cæcal appendages were 34–39, or appertaining to the northern race. This rendered it clear that reliance could not be placed on these figures; the proposed formula of vertebræ and cæcal appendages were not found correlated at Colesbourne on investigation, and therefore could not be depended upon as invariable in other places. The next locality from which the examples came that I minutely investigated were from Cardiganshire, already referred to; and here again an anomaly was found. The number of vertebræ were from 57 to 60, but the cæcal appendages from 35 to 44. Tabulated, they would be as follows:—

Salmo fario,	northern form (*Günther*),	Vert. 59–60,	cæc. append.	33–46.
"	southern " "	" 57–58,	"	38–47.
"	from Gloucestershire	" 57–58,	"	34–39.
"	" Cardiganshire	" 57–60,	"	35–44.

The foregoing results threw strong doubts upon the validity, first, of how the species had been subdivided, and, secondly, as to their distribution; while, if the number of vertebræ in all the seven forms of non-migratory freshwater trout inhabiting our islands merely varies between 56 and 60, I possess examples from one locality (Cardiganshire) in which they differed from 57 to 60, and in an example of the same variety from Penzance I have only found 56. Dr. Cobbold likewise gives an instance of a Scotch trout (*S. fario*) that he examined, and which had only 56 vertebræ. It is evident that too much stress has been attached to the number of vertebræ in trout; and no confidence can be placed on such as affording evidence of specific difference.

We thus arrive at the remarkable fact that the form considered by Dr. Günther as *S. fario* may possess from 56 to 60 vertebræ, which are exactly the extreme limits he ascertained existed among all the freshwater non-migratory trout of the British Isles.

Then, as to the number of these bones which are present, some other facts should not be overlooked. This family of fish is exceedingly prone to affections of the spinal column. Occasionally two small vertebræ take the place of one large one, as if a division had occurred; while in others may be observed an abnormally large one, as if two had coalesced, as shown by the normal number of hæmal spines for two vertebræ being present. Dr. Günther, in his interesting volume, even instances a case "where three vertebræ were united."

The number of cæcal appendages has been adduced as a character which may materially assist in fixing a species; and if unexpected variations occur, their cause, it is asserted, may be found in the partial confluence of the cæca. Dr. Günther gives the extreme limits of variation in his six species of non-migratory freshwater trout (excluding the Loch-Leven) as being between 33 and 50. But it appears to me that the difficulty does not appear so much in discovering variations, as in determining within what fixed number they exist in a given form: thus in Gloucestershire I found them at least from 34 to 39, and in Cardiganshire from 35 to 44. The question first requiring solution is, whether the number of these appendages is persistent or inconstant, and whether change of climate and food may occasion any variation.

I must here refer to the Tasmanian experiment, wherein it appears that the common brook-trout of the Thames and the

south of England has so altered since its introduction into the waters of the Antipodes that the breed has increased in size, while, food being abundant, certain organic changes have occurred. Dr. Günther, in an interesting manner, ignores the facts thus obtained by observing that "it is a fact that numerous cross-breeds have been introduced into and reared in Tasmania, which must more or less interfere with the character of the pure breeds" (Introd. p. 642). Neither does this view agree with his theory that "the hybrids mix again with one of the parent species, thus producing an offspring more or less similar to the pure breed" (*l. c.* p. 631)*. I therefore prefer accepting the statements of Mr. Allport and Mr. Arthur, more especially as their correctness as to whence the ova came is capable of being verified, and with respect to this I have been at some considerable pains. The trout-ova (1200 to 1500) sent by Buckland in 1864 came from fish taken "in a branch of the Itchen which runs through the garden of Admiral Keppel, at Bishopstoke, near Winchester" (Buckland, Brit. Fishes, p. 317); while the readers of the 'Field' have been informed, upon what appears to be reliable evidence, that the remainder, which were sent by Mr. Francis Francis, were obtained from brook-trout inhabiting streams that are affluents of the Thames.

To obviate errors, I will trace as briefly as possible the whole of this interesting experiment (except as to the collection of the ova, which has already been referred to)—when the eggs were sent out, and what became of them. From at least 1200 to 1500 trout-ova were despatched in the ship 'Norfolk,' which left Falmouth on January 28th, 1864, anchored at Hobart Town on April 20th, and on the 21st reached the ponds, about 300 trout-ova arriving alive. In Mr. Allport's account, "on the 8th day of February, 1866, the ship 'Lincolnshire' left Plymouth bound for Melbourne, having on board about 103,000 ova of salmon (*Salmo fario*†) and 15,000 ova of sea-trout (*S. trutta*), stowed in an ice-house," reaching Hobson's Bay on the 30th April, 1866 (see Proc. Zool. Soc. 1870, p. 23); but he alludes to the ova

* Examined from a different point of view, it may be asked to what original breed of British freshwater non-migratory trout have these fish reverted, if the British-Museum Catalogue is correct that none, except the Loch-Leven, have more than 50 cæcal appendages? for the Otago ones (New Zealand, distributed from Tasmania) show as many as 54.

† This probably means *S. salar*, but may refer to both.

subsequently as those of the salmon. Anyhow, any trout-ova received came from Mr. Francis Francis, who obtained them from an affluent of the Thames. On July 3rd, 1866, the first pair of trout matured in Tasmania had the ova and milt taken from them. "The ova shipped to Tasmania consisted of three * batches of eggs, supplied through the kind offices of Mr. Frank Buckland and Mr. Francis Francis," and were obtained from the localities alluded to. Mr. Arthur † informs us that the first successful trout-hatching in Otago occurred in October 1868, from 800 ova obtained from the natural spawning-beds of *S. fario* in Tasmania; these and a second lot the subsequent year formed the whole of their original stock, some of which were first liberated in the streams in November 1869.

As these New-Zealand fish are clearly descendants from our brook-trout (*S. fario*), it is evident that they might be expected to correspond in structural characters with their ancestral stock. But results show that they have not done so. Without entering minutely into Mr. Arthur's interesting paper, which should be studied in the 'Transactions' of the Society in which it was published, I will restrict myself to his conclusions. Scotch trout, according to Stoddart, show a yearly increase of about one third of a pound in weight; while in Otago they grow so rapidly and are so fat that they have reached an average yearly increment of from 1 lb. to $2\frac{3}{4}$ lb. Already the various streams have stamped the trout with local peculiarities: in some they are plump almost to deformity; their proportions are not constant, neither are their colours; while examples are said to have been seen up to 20 lb. in weight. What is of extreme interest, however, is, as already remarked, that these fat fast-growing fish have not the number of cæcal appendages of their ancestors, but with increased necessities, due to a superabundant supply of food, they have augmented in number—not varying between 33 and 47, the extreme limits Dr. Günther assigns to the *Salmo fario*, but from 43 to 54; while among the entire six British species he described (Loch-Leven trout not included) he limited these appendages to between 33 and 50. Thus the brook-trout, transported to a climate where food is abundant, has taken on structural changes affording a most conclusive proof that the

* Buckland says he believes Mr. Francis Francis sent some trout-eggs obtained from Hungerford at the same time as his were forwarded.

† Transactions of the Otago Institute, July 9th, 1878.

number of cæcal appendages is no more a criterion of species than are the number of the vertebræ. Had these New-Zealand examples been submitted to Dr. Günther prior to 1865, they would undoubtedly have formed at least another new species for the British-Museum Catalogue; while his views, as given in his late work, appear to have undergone but little, if any, modification*.

Respecting the form of the preopercle, the size of the head, and the dentition, wide differences exist in this fish, in accordance with age, sex, and other causes, and which do not call for a detailed examination in this place. I will therefore pass on to variations in colour—first, internally, and, secondly, externally.

The flesh of trout may be of a red or of a white tint, due, it has been frequently shown, to the food which the fish consumes. And this difference in the food may be consequent either on necessity or choice. Thus, in one river, as at Alresford in Hampshire, crustaceans may be obtained in the lower portion of the stream, not so in the upper; in the former the cooked fish cuts pink, in the latter nearly white. It would also appear that, even if the necessary food for occasioning the pink appearance is present it does not follow that the fish selects it, as there are rivers in which some of the brook-trout are red while the others are white, both forms being in good condition and equally excellent when served at table. Reverting to the *Salmo fontinalis*, or American charr, which undergoes the same changes in this country as *S. fario* does in New Zealand, what do we find? The young, as I observed, have been turned out and acclimatized here, and with the following result as regards this question. Those which have been liberated in the streams in Cardiganshire are, as food, observes Sir P. Pryse, "very good, the flesh having a peculiar gamboge colour, and rich;" while Mr. Francis Francis tells us, respecting others from Sir James Maitland's, in Perthshire, that their condition left nothing to be desired: they were fat and firm; the flesh was of a beautiful pearly white ('Field,' March 11th, 1882). A subsequent correspondent (Coracle, 'Field,' March 18th, 1882) states that he has also seen it in this fish perfectly

* It is difficult to admit that all non-migratory trout not agreeing in their fin-formula, their number of vertebræ, and cæcal appendages with the descriptions given in the British-Museum Catalogue, are to be termed hybrids. It seems more rational to surmise that Nature's limits of variation are more extensive than those admitted by Dr. Günther.

pink. It is clear, from the foregoing differences in colour in the flesh of an unquestionably single species of *Salmo*, that it may be pearly white, perfectly pink, or of a gamboge colour, but equally good for the table, the fish being in good condition in all the several forms.

The external colours of these fish (omitting such as are due to age, condition of health, or the breeding-season) vary in a very wide manner, in accordance with the localities they inhabit, the nature of the soil or bottom of the water, the rapidity or the reverse of the current, the extent and depth of the water, as well as the food, light, and temperature. Clear water in rapid rivers or lakes, especially when the bottom is pebbly, often contains somewhat silvery fishes with black X-shaped marks. Many experiments have been made, showing how rapidly one of these fishes may change colour. "Put a living *black* burn-trout into a white bason, and it becomes within half an hour of a light colour. Keep the fish living in a white jar for some days, and it becomes absolutely white; but put it into a dark-coloured or black vessel, and although on first being placed there the white-coloured fish shows most conspicuously on the black ground, in a quarter of an hour it becomes as dark-coloured as the bottom of the jar, and consequently difficult to be seen" (St. John, 'Natural History and Sports in Moray,' p. 25). All practical anglers know how trout of very different colours may be captured from contiguous streams, or from ponds into which they have been introduced, from what they were when originally placed there. "Unquestionably," observes Stoddart ('Angler's Companion,' 1847, p. 3), "there exists no species of fish which, judging of it by the external marks, holds claim to so many varieties as the common freshwater trout. In Scotland almost every lake, river, and streamlet possesses a breed peculiar in outward appearance to itself." Jurine, respecting the fishes of the Lake of Geneva, observes that the common trout, salmon-trout, lake-trout, river-trout, the alpine trout, &c. are all referable to differences of sex, age, season, the nature of the water, food, light, &c. (Mém. de la Soc. de Phys. et d'Hist. Nat. de Genève).

If some trout esteem food which causes their flesh to be tinged with red, while others in the same water appreciate a different sustenance, and consequently are not thus tinged, if the Gillaroo eats shells, occasioning thickening of the middle coat of its stomach,

while such diet, as a rule, is rejected by the common variety of *Salmo fario*, it appears to point out that the tastes of some differ from those of their companions; while it is a well-known fact that certain forms of food promote fish-growth more rapidly than others. Mr. Stoddart gives the result of an interesting experiment on trout:—"Fish were placed in three separate tanks, one of which was supplied daily with worms, another with live minnows, and the third with those small dark-coloured water-flies which are to be found moving about on the surface under banks and sheltered places. The trout fed on worms grew slowly, and had a lean appearance; those nourished on minnows (which, it was observed, they darted at with great voracity) became much larger; while such as were fattened upon flies only, attained in a short time prodigious dimensions, weighing twice as much as both the others together, although the quantity of food swallowed by them was in nowise so great."

If a trout, normally belonging to a small race, as *S. cornubiensis*, is transferred to a reservoir or lake where food is plentiful, it attains a size to which it never reaches in its ancestral stream, showing capacity for growth to be inherent, and called into action by luxuriant living. In Scotland the largest examples are in lochs, so also in Wales and Ireland—although occasionally a large one may be found existing in a sluggish stream, especially if such passes over a rich soil. Should food be plentiful, a brook-trout may attain to many pounds weight in suitable localities—in fact, to as large a size as the great lake-trout, which I hold to be merely a form of *S. fario* which indulges in luxurious living or cannibal propensities.

The first so-called species which I propose alluding to is *Salmo nigripinnis*, Günther, 1865, or *S. cornubiensis* as described by Borlase, Artedi, &c., and which for many reasons may be considered the young of *S. ferox*. I have been most liberally supplied with specimens from Cardiganshire, through the kindness of Sir Pryse Pryse; and among them is one form which was alluded to by Barrington, in the 'Transactions of the Royal Society' for 1774, as the "Hog-backed Trout of Plinlimmon," which Dr. Günther, as I believe correctly, considered identical with his *S. nigripinnis*. My example is a peculiarly interesting one, as showing a link between *S. nigripinnis* and *S. ferox*, pertaining partially to one form and partially to the other. The

following are the differences noted in the British-Museum Catalogue:—

Salmo nigripinnis.	*Salmo ferox.*
D. 14, A. 12, P. 13, L. l. 120–125, Cæc. 36–42; Vert. 57–59.	D. 13, A. 10–11, P. 16, L. l. 125, Cæc. 44–49; Vert. 58–59.
Head small. Preopercle with an indistinct lower limb. Snout not much produced in males. No mandibular hook observed. Head of vomer with a transverse band of teeth, on body generally a single series. Female mature at 7 inches. Largest example observed, 16 inches.	Head of moderate size. Preopercle crescent-shaped, without any angle (or distinct lower limb). Snout much produced in males. Mandibular hook when spawning. Head of vomer small, toothless; body with a double or zigzag line of teeth. Caudal truncated at 18 inches, in larger examples rounded. Female mature at 14 inches. Largest example observed, 31 inches.

These reputed two species have been found residing in nearly or quite the same localities* in England, Scotland, Wales, and Ireland. The size of the specimens is important, as modifying the conformation of the opercular pieces, as well as of the fins, the character of the scaling, the proportional diameter of the eye, and the existence, or the reverse, of teeth on the head of the vomer, so frequently partially or entirely absent in the non-migratory freshwater trout, more especially after attaining to a large size. The teeth being present on the head of the vomer in the smaller (*S. nigripinnis*), but absent from the same place in the larger ones (*S. ferox*), is merely symptomatic of edentulation due to age. The same argument applies to the mandibular hook, it being well known that among the Salmonidæ this production is absent in young males, as may be readily observed in the parr which possess milt ready for exudation and which has been stated so long ago as by Willughby, and proved by Shaw, to be capable of fertilizing the ova of the salmon. The number of pectoral rays is of no consequence, as I find, even in the British-Museum specimens, examples of *S. nigripinnis*, *S. ferox*, and *S. fario* possessing from 13 to 15.

The foregoing leaves the following as Dr. Günther's primary reasons for dividing these two so-called species:—*S. nigripinnis* has D. 14, A. 12, head of the vomer toothed, and generally a

* Wallace ('Island Life,' p. 322) observes that it is not found in Ireland, but acknowledges Dr. Günther as his informant; while Irish examples exist in the British Museum, and that habitat is admitted in the 'Introduction to the Study of Fishes,' as well as in the British-Museum Catalogue.

single row along the body of that bone; caudal fin with pointed lobes. *S. ferox*: D. 13, A. 10–11; no teeth on the head of the vomer, but a double row along the body of the bone; caudal fin truncated*.

The example of the "hog-backed trout" (which I exhibit) has D. 14, teeth on the head of the vomer, and a distinct lower limb to the preopercle, thus belonging to *S. nigripinnis*. Likewise A. 11, a double line of teeth along the body of the vomer, and the caudal fin truncated, which is given as diagnostic of *S. ferox*.

I have likewise six smaller examples of *S. nigripinnis* in which teeth are present on the head of the vomer and in a zigzag line along the body of that bone; the caudal fin in the smallest has pointed lobes, which have become rounded in larger specimens; the cæcal appendages varied from 35 to 44. In some of these fish the posterior margin of the preopercle was rounded, and had no distinct lower limb. The maxilla was much feebler than seen in some other local races of brook-trout, which was remarkably the case on comparing it with a beautiful Yorkshire variety sent me by Mr. G. Brooks, F.L.S.; but among these Yorkshire specimens I found great differences to exist.

I now determined to go to Cornwall and ascertain whether the *S. cornubiensis* really differed from a young *S. nigripinnis*; and the first thing I ascertained at Penzance was, that the little brook-form, if placed in large pieces of water, attained to several pounds in weight. I obtained a considerable number which externally only differed from *S. nigripinnis* in colour, the parr-marks of the young stage being continued throughout life in these small trout taken from the streams. The brook-trout from the Cotteswolds has as weak a maxilla as the *S. nigripinnis*, although it is clearly a typically-coloured *S. fario*.

Salmo orcadensis, Günther, 1865.—In the 'Catalogue of the Fishes in the British Museum,' vi. p. 91, it is observed that "Sir J. Richardson mentions this trout in the Fauna Bor.-Amer. Fish. p. 142, referring it to the 'Frith-trout;' but this appears to have the maxillaries feebler and the scales smaller." In examining this question, we undoubtedly find that in the third edition of Yarrell's 'British Fishes,' edited by Sir J. Richardson, allusion is made to the Loch-Stennes trout under the head of the

* "The caudal fin (in Salmonoids) especially undergoes considerable changes with age, and dependently upon the sexual development. Young specimens of all species have this fin more or less deeply excised." (Günther, Cat. vi. p. 5.)

grey trout, *Salmo eriox*. At vol. ii. p. 236, it is stated, "Mr. Low says it is found in the Loch of Stennes, Orkneys." But this is not, I think, the form Dr. Günther terms *S. orcadensis*; for at p. 288 (Yarrell, *l. c.*) it will be seen that another race of trout is recorded as existing at the Orkneys, and which is considered *S. ferox*. "The Rev. Mr. Low, 'Fauna Orcadensis,' mentions a trout of 36 lb. weight or more, which, along with the common trout, occurs both there and in Zetland." Thus it clearly appears that three forms were considered to exist in the Orkneys—the grey trout, great lake-trout, and common trout. Now Low expressly said that there are salmon in the sea, although he had only heard of four instances of such; and three (if they were salmon) were killed and brought on shore by otters from the sea, and picked up subsequently by the country people; while the fourth stuck in a mill-wheel, and was caught by the miller. In his time (prior to 1795) Low had been informed of a salmon-fishing that had formerly existed at the mouth of the Loch of Stennes, and of heritors who had such a fishing in their charters, the old people still showing a place where cruives were placed; but such had long since been given up. Vast quantities of salmon, he continues, were caught in the rivers of Caithness, which are right against and only separated from the Orkneys by the Pentland Frith, and from thence he supposed the stragglers came.

It will thus be seen that probably *S. orcadensis*, Günther, a non-migratory form of trout from Loch Stennes, is identical with the "large trout" mentioned by Low as existing in that locality, and which has been referred to *S. ferox* by Yarrell and Richardson. Dr. Günther most justly compares his examples to *S. nigripinnis*, to which he observes "it is very similar," but distinguished from it "by a broader and stronger maxillary, larger scales on the tail, and a greater number (50) of cæcal appendages." The same author, and also Thompson, found 49 in the great lake-trout.

About two years since I obtained from Waterford two examples of trout exactly similar in shape &c. to the types of *S. orcadensis*; they are respectively 13 and 14 inches in length. Some of the spots on the head are ocellated, as seen in freshwater forms; whereas others are X-shaped, as is frequently perceived in such as are taken in the sea. The teething is complete, having a row across the head of the vomer, and a double zigzag line along the body of that bone.

It now becomes necessary to consider the relationship existing between *S. nigripinnis*, *S. orcadensis*, *S. ferox*, and *S. fario*. Among our earlier British ichthyologists we find that Berkenhout (Sym. 1795, p. 79. sp. 3) termed the "great lake-trout" *S. lacustris*, supposing it to be identical with the continental variety; but of late years differences have been asserted to exist between the British and foreign race. Jardine and Selby termed ours *S. ferox*, as will be seen in the 'Encyclopædia Britan.' (edition vii., art. "Angling," p. 142) and in the 'Edinburgh New Philosophical Journal' (xviii. p. 55), the specific name having been chosen to characterize its size and voracious habits. I have already alluded to Jurine's opinion of the specific identity of all these forms in the Lake of Geneva; and it would be but reasonable to expect that if the British *S. fario* under favourable conditions could attain the size of *S. ferox*, the continental *S. fario*, which is the same species, would, under like conditions, also arrive at being a great lake-trout. Collett (1875) in Norway, Feddersin in Denmark, Moreau (1881) in France, can only see in the numerous races of freshwater trout varieties, and not species; while the last author (vol. iii. p. 534) places among the synonyms of *Trutta* (or *Salmo*) *fario*, "La Forelle du Lac Lëman, *Fario Lemanus*;" and at p. 536 observes, "La *Truite fèroce*, *Trutta ferox*, Valenc., des eaux du Foretz est une simple variété de la *Truite ulgaire*, et nullement une espèce particulière."

Although these authors have, in my opinion, been perfectly correct in their views, still there existed this fact, that Dr. Günther had given structural differences existing among the specimens in the British Museum, showing that *S. ferox* possessed 56 to 57 vertebræ and 43 to 49 cæca, while *S. fario* had 57 to 60 vertebræ and 33 to 47 cæca. I have, however, now shown that examples of *S. fario* may have from 56 to 60 vertebræ, and likewise from 33 to 54 cæca, thus overlapping the entire amount of variations as described.

What differences have been brought forward to differentiate *S. ferox* from large examples of *S. fario*? Sir William Jardine stated that "the dorsal fin contains 15 rays, and appears to be constant in that number;" and that "in form it is generally shorter proportionally and deeper than large specimens of *S. fario*." Sir J. Richardson distinguished between the great lake-trout and brook-trout by the size it attains. The tail "in adults is perfectly square, or might even be described as slightly rounded

at its extremity; in the young it is slightly forked, and appears to fill up gradually as the fish advances in age." The relative position of the fins is different; the number of rays in the dorsal varies from 2–4/11 or 13 to 15; and the scales along the lateral line are of a different form. Thompson observes that he found from 33 to 49 cæca in various examples of *S. ferox* from 12 to 17 inches in length.

I possess undoubted examples of the common brook-trout having from 13 to 15 dorsal rays; while as to the caudal fin being square in adults, so it is also in large examples of the brook-trout. Yarrell (ed. 3, i. p. 281) gives an illustration of a large Thames trout (a locality not frequented by *S. ferox* according to authors), in which the caudal fin is as rounded as in any examples of great lake-trout of similar size. It was a male, 28 inches long, having a hooked lower jaw, while it weighed 11 lb. The comparative length of the head and height of the body are almost identical with what obtains in an example of *S. ferox*, 20 inches long, from Llanberris, and which is in the British Museum. I examined a few years since a specimen (which is still preserved) of trout, weighing upwards of 13 lb., taken from a large sheet of water at Alresford in Hampshire, which is well stocked with coarse fish. This was one of about a dozen that some years previously had been transferred from the contiguous stream, to which they could not subsequently obtain access. It is believed that in such situations trout do not breed, but, if food is plentiful, they attain to a large size. Without a history of whence this fish came, I maintain that no ichthyologist could be certain whether it is or is not a great lake-trout.

"The trout," says Dr. J. Davy, "when it feeds principally upon fish must be extremely active and strong; consequently, from its predatory mobile habits, acquires large teeth, large fleshy fins, thick skin, and great pectoral fins for turning. When it feeds on shell-fish, it gets the stomach of the charr and its colours as in the Gillaroo trout."

A race of trout found in Ireland has from time immemorial been known as the Gillaroo, distinguished by the thickness of the middle coat of its stomach. The first mention of this fish is in a paper by the Hon. D. Barrington, read at the Royal Society, December 23, 1773, when he observed "there are no exterior marks by which the species on the table can be distinguished from the common trout." The fishermen observed that "the

largest Gillaroo is $12\frac{1}{2}$ lb.; the smallest 2 lb. There is a red Gillaroo and a white; the last is the smallest and the better eating. It is white with black spots on it; the red Gillaroo is red with black spots on it."

Trout, as already remarked, are exceedingly liable to variation, whether such is due to local or constitutional causes. Some of these abnormal productions would seem to be hereditary; in others the same exciting cause continuing in action occasions the same results as in previous generations. Giraldus Cambrensis, lib. iii. c. x., the traveller and Archdeacon of Brecon, who attended Baldwin, Archbishop of Canterbury, in a progress through Wales in 1188, tells us of trout existing in the lakes of Snowdon which possessed only one eye. The Fischau, near Mandorf in Germany, was reputed to contain blind trout (Fr. Ern. Bruckmanni Epist. Itin. xxxvi. Wolfenb. 1734, p. 10). A deformed race of trout is asserted to exist in a small loch in Inverness-shire near Pitmain: among them there appears to be an arrest of development in the upper jaw, giving their heads a slight resemblance to those of bulldogs, due to the projection of the lower jaw (Encyc. Brit. 7th ed., art. Ang.). In Loch Islay is a race of tailless trout. At Malham Tarn, in Yorkshire, the trout are distinguished by a deficiency or malformation of the gill-covers. On Plinlimmon, and in adjacent parts of Wales, are "hunch-backed" trout, having deformed vertebral columns, as already alluded to. There are likewise races in which some local cause has set up local action, as of the stomach alone. This variety, due to the food it indulges in, has the muscular coat of its stomach thickened, which abnormal structure has been reproduced in succeeding generations. For it must not be assumed, because in certain examples we are unable to find *Limnæa* and other shells, that the fish has never consumed any; they may have been digested, or it may have varied its food, or the shells may have been temporarily unobtainable. But prior to considering this modification as of a specific character, it may be worth while to ask whether such is solely restricted to the Gillaroo, which, in the British-Museum Catalogue, vi. 1865, is termed *Salmo stomachicus*, Günther.

Thompson ('Natural History of Ireland,' iv. 1856) justly observes that "the coats of other species of *Salmones* than *S. fario* (of which *only* the Gillaroo is set down as a variety) become muscular from the same cause. I have seen *S. ferox*, from different localities, with a muscular stomach; and these examples

were called Gillaroo trout by persons who distinguish these from the ordinary state of the fish, believing them to be a distinct species." Sir Humphry Davy remarked that if they are the common trout which have gained the habit of feeding on shell-fish, "they have altered in a succession of generations. The common trout of this lake have stomachs like other trout, which never, as far as my experience has gone, contain shell-fish; but of the Gillaroo trout I have caught with a fly some not longer than my finger, which have had as perfect a hard stomach as the larger ones, with the coats as thick in proportion and the same shells within; so that this animal is at least now a distinct species, and is a sort of link between the trout and charr, which has a stomach of the same kind with the Gillaroo, but not quite so thick, and which feeds at the bottom in the same way." Sir J. Richardson observes:—"We may here note the existence of a strongly-marked and peculiar variety, called the Gillaroo trout of Galway. It is remarkable for feeding on shell-fish, in consequence of which (it is supposed) the coats of the stomach acquire a great degree of thickness, from which peculiarity it is sometimes called the *gizzard trout*." Sir H. Davy remarks that "the charr of the lakes of Southern Austria feeding similarly (to the Gillaroo trout) have a like thick stomach."

I must confess being unable to understand by what process of reasoning any ichthyologist who considers the common trout and the great lake-trout distinct species can admit that, if both *Salmo fario* and *S. ferox* have thickened walls to their stomach, the first is to be constituted a distinct species as *S. stomachicus*, whereas in the latter it is merely to be deemed a variety.

Salmo gillivensis, Günther, 1865, or *S. estuarius*, Knox ('Zoologist,' 1855, xiii. p. 4662), is similarly coloured to freshwater forms; while the young (in the National collection) so exactly resembles the *S. cornubiensis*, that it is impossible to doubt their specific identity. Knox's example had 60 vertebræ, similar to the number present in the British-Museum specimen.

The last British form which I propose briefly alluding to is the Loch-Leven trout, *Salmo levenensis*, that appears, at least from the specimens I have examined, to possess a considerably shorter head than any of the varieties of the freshwater non-migratory brook-trout; while the number of its cæca has been observed to vary from 49 to 90. This appears to be probably a descendant from some marine form which, having obtained

access from the sea, has had its retreat to the ocean cut off, and has consequently now taken on a freshwater existence. Its numerous cæcal appendages seem to show its affinities are more related to marine than freshwater forms; while its grey colour and black spots are also what are seen in salt-water residents. It may be that the theory I heard in Scotland is correct, and that the anadromous *Salmo albus** was the ancestor of this, a now freshwater non-migratory trout.

Before concluding this paper I must remark upon what anadromous species of Salmonidæ I allude to when using the term *Salmo albus*. It is the fish known as the *White Salmon*, Pennant (1776), *Salmo albus*, Artedi, *S. phinok*, Turton (1807), *S. brachypoma*, Günther (1866); but by the majority of recent authors placed as a synonym to *S. trutta*.

Pennant, in his 'British Zoology' (ed. 1776), iii. p. 302, described a *white salmon* from the Esk in Cumberland, where he observed that it was obtained from July until September, that it never exceeded a foot in length, and that "this is the fish called by the Scots *Phinoc*." Bonnaterre, 'Encyclopédique Ichthyologie' (1788), p. 161, referred to Pennant's fish as *Salmo albus*; in Schneider's edition of Bloch (1801), p. 409, and in Lacépède's 'Histoire Naturelle des Poissons,' v. p. 219, this term was continued; so likewise in Fleming, 'British Animals' (1828), p. 180, where he also called it the "Whitling, Hirling. Common in the sea and rivers of Scotland and the north of England," and that it spawned in August and September. Jardine described it in the 'Edinburgh New Philosophical Journal,' xviii. p. 40; and likewise gives an excellent figure of it (No. III.) in his Plates of Salmonidæ, appending the name *Salmo albus*, Fleming, but which he considered a synonym of *S. trutta*, of which likewise he gives a recognizable illustration.

It was about this time that *S. albus* began to be suppressed under the belief that it was the young or a variety of the salmon- or sea-trout. Jenyns placed it as *Salmo trutta* in his 'Manual of British Vertebrate Animals' (1835), p. 424, observing that neither he nor Yarrell could see any appreciable difference between them. Parnell, 'Wernerian Memoirs,' vii. (1838), p. 295, White, in his 'List of the Specimens of British Animals in the Collection of the British Museum' (1851), p. 75,

* I leave to a future date the consideration of whether *S. albus* is or is not a synonym of *S. trutta*, and also further remarks on *S. levenensis*.

and Thompson, 'Natural History of Ireland' (1856), iv. p. 151, adopted the same view; while it is worthy of note that examples of the species here referred to are still in the National museum received from the collections of Yarrell and Parnell.

Lastly, Dr. Günther, in the 'Catalogue of Fishes in the British Museum' (1866), vi. p. 23, with a more extended collection, reverted to the opinion of Pennant, and remarked how the species differed from *S. trutta*, five out of seven of his types being from Yarrell's and Parnell's collections. But, probably due to some oversight, he placed all the synonyms of *S. albus* under the head of *S. trutta*, even when the authors had referred to both. It thus came to pass that this northern species, or *S. albus*, has since 1866 been known as *S. brachypoma*, Günther, which is the more remarkable, as, prior to the publication of the volume referred to, the author was able to record in the Addenda, p. 357, that he had received examples from the Beauly, "and that they are named there 'Phinok.'"

Finally, I may observe that now we possess absolute proof of what previously has been supposed by most practical anglers and ichthyologists—a change of habitat may eventuate in a structural change in trout so marked, that either the New-Zealand forms, all descended from our brook-trout, must be allowed specific rank, or the six various species of non-migratory freshwater forms admitted into the British-Museum Catalogue must be relegated to *Salmo fario*. We find the number of vertebræ in all six may undoubtedly exist in one form; while the cæcal appendages may be augmented in number to an extent unknown in this country. That the size of the great lake-trout may be attained by the brook-trout indulging in luxurious food and resident in a suitable habitat is also evident; while the largest races may become dwarfed by insufficient or inappropriate food and unsuitable localities.

This question of whether our non-migratory freshwater trout (excluding the Loch-Leven) are local races or distinct species is not merely a curious one or of passing interest, but has, I believe, a practical bearing upon pisciculture. If all these races are distinct species and they were interbred, hybrids would result; and hybrids have a tendency towards sterility: but we are told they are as prolific as the parent stock. This last fact goes towards corroborating my contention, which is, that we are not dealing with species and obtaining hybrids, but we are crossing

varieties or local races, and mongrels are the result. Consequently sterility need not be anticipated; but, on the contrary, improvement is more likely to ensue (should there be no deficiency in food) than when the stock is bred in and in.

It also tends to show that where small, but not malformed, breeds of trout exist, riparian proprietors had far better investigate the condition of the food-supply and nature of the waters in their streams than rely upon the introduction of larger races. They may be assured that the Gillaroo, when it cannot obtain shellfish, will in time lose its thickened stomach; and descendants of the various malformed varieties which I have alluded to will revert to common brook-trout—that, in short, sooner or later new stock will become indistinguishable from the original local breed in colour, form, and size.

On a Marine Caddis-fly (*Philanisus*, Walker, = *Anomalostoma*, Brauer) from New Zealand. By R. McLachlan, F.R.S., F.L.S., Hon. Memb. N.-Z. Institute.

[Read June 15, 1882.]

In April of this year I received a letter from Prof. F. W. Hutton of Canterbury College, Christchurch, New Zealand, in which was the startling announcement that the larva of a Caddis-fly lives habitually in rock-pools, *between high and low water-marks*, in Lyttleton Harbour in that colony, and forms its case of coralline seaweed. He had often attempted to rear the perfect insect, but only once succeeded, and then when he was away from home; so that only the dead remains were obtainable*. Prof. Hutton gave me the welcome intelligence that these remains, with larva and case, were on their way to this country in charge of a friend who was coming home. This gentleman (Mr. C. C. Bowen, Governor of the Canterbury Province) recently arrived, and the materials are now in my hands.

We are so accustomed to associate Caddis-worms with fresh water, that the arrival of these materials was awaited by me with not unnatural impatience. We are already acquainted with a terrestrial species (*Enoicyla*); but no truly marine form had

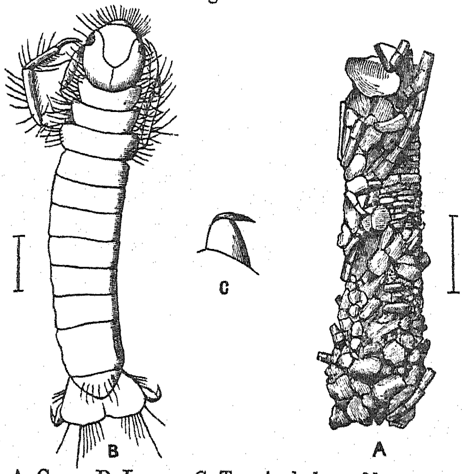
* A short notice to this effect was published by me in the 'Entomologist's Monthly Magazine,' vol. xviii. p. 278 (May 1882).

been recorded. It is, I believe, known that at least one species can exist in the brackish water of the shores of the Baltic, at any rate in the vicinity of the mouths of large rivers. Others certainly manage to exist in marshes that are liable to the occasional influx of salt water during high tides, and in pools near the sea-shore into which sea-water sometimes enters in large quantities during storms. These instances, however, scarcely affect the matter now under consideration. So far as I can ascertain, these New-Zealand larvæ are quite outside the influence of river-water; and the materials of which the case is chiefly composed appear to prove this.

The specimens before me are not in good condition on the whole. They consist of:—

(i.) A straight tubular cylindrical case (fig. 1, A), 10 millim. long by nearly 3 millim. in diameter, which is nearly equal throughout. To the inner silken tube are attached fragments of some white coralline seaweed (with a few quartz[?]fragments &c.), arranged in no special order. In one or two instances the fragments are larger, showing the jointed nature of the alga; but mostly they consist of single joints. The case is empty; but I think it was a pupa-case, one end showing signs of having been closed in a manner that is usual when the inmate is in the pupal condition.

Fig. 1.

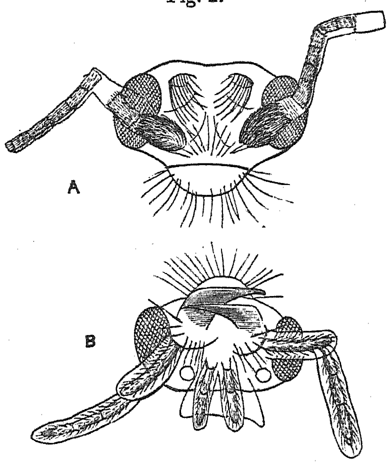


A. Case. B. Larva. C. Terminal claw of larva.

(ii.) A larva (probably young), mounted as a transparent object on a microscopic slide, crushed and a good deal damaged. This larva (fig. 1, B) is 6 millim. long. The head is rounded oval in form, blackish above, but with three pale spots, one posteriorly, the two others (smaller) on each side of the disk; there are also pale dots round the small eye-spots; the anterior margin and labrum are provided with long hairs. Viewed from beneath, the mouth-parts

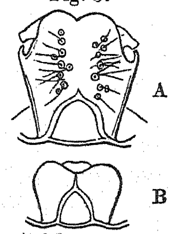
are not discernible. The pronotum is narrow and transverse, but with the anterior angles much produced; the colour is testaceous, mottled with paler; fringed with long hairs. Mesonotum similar in form, but somewhat broader, and the angles less produced; almost entirely pale yellowish, slightly mottled with testaceous; less chitinous than either the head or pronotum. Metanotum the broadest segment of the thorax, scarcely chitinous; the sides apparently with a hair-bearing tubercle. Legs wholly bright yellow; the anterior pair short, the two other pairs longer (not extraordinarily long) and nearly equal. All the legs are simple (without teeth or spines), and present nothing unusual in form; the claw very long and curved. Abdominal segments having the sides nearly parallel, apparently bright yellow in life; terminal segment dilated, its posterior margin angular and notched in the middle. Anal claw (fig. 1, C) very short, piceous, much curved, and seated on a strong protuberance; on either side of the posterior margin of the anal segment is a tuft of very long black hairs. I can discover no trace of stigmata in the larva in its present condition; and the respiratory filaments are rather uncertain; but there are distinct traces of bundles composed of three or four short filaments on either side of the ventral surface of the first and second abdominal segments; on the other segments I cannot define traces of filaments.

Fig. 2.



A. Head of pupa, above. B. Same, beneath.

Fig. 3.

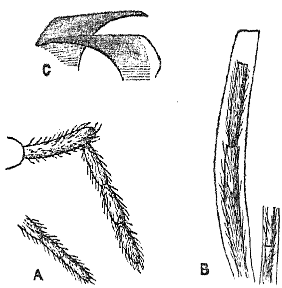


A. Mesonotum.
B. Metanotum.
Of pupa.

(iii.) On the same slide are disconnected fragments (figs. 2, 3, and 4. Fig. 2. A, B, head above and beneath: fig. 3. A, B, mesonotum and metanotum: fig. 4. A, maxillary and labial palpi; B, portions of tarsus; C, mandibles) of what Prof. Hutton assumed to be the perfect insect. Here he was a little mistaken. The frag-

ments are those of a male pupa which had died before transformation, probably from being without any thing in the jar of water up which it could crawl into the open air for metamorphosis. All the fragments show the transparent pupa integument enveloping the perfect insect, which was fully formed and ready to emerge. Ordinarily it would be almost impossible to identify a species from such fragments. The mandibles are very long and strong, sickle-shaped, but considerably dilated at the basal articulation (they are more formidable structures than are often seen in Trichopterous pupæ). But neither these, the antennæ, nor the unexpanded wings would have given any clue had the maxillary palpi not rendered identification both possible and certain. These organs prove that the New-Zealand marine Caddis-fly is no other than *Philanisus plebejus*, Walker (= *Anomalostoma alloneura*, Brauer), a species in which the maxillary palpi of the male present a remarkable and unique conformation of the second joint, which is very long, curved, *and having the insertion of the third joint placed considerably before its apex.* (In the female the second joint is also long; but the third joint is inserted, as is usual, *at* its apex.)

Fig. 4.



A. Maxillary and labial palpi. B. Portions of tarsus. C. Mandibles.

So far this is a very satisfactory conclusion to arrive at. But *Philanisus plebejus* is already known from several localities in New Zealand; and one would like to know if it is *always* found on the sea-shore. The other locality-records give us no information on this point.

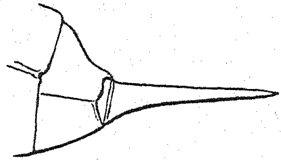
The insect was first noticed (I can scarcely say "described") by Walker in 1852, in Part I. of the 'Catalogue of the Specimens of Neuropterous Insects in the Collection of the British Museum,' p. 115, as a new genus and species which he termed *Philanisus plebejus*, indicated as from "New Zealand, Dr. Sinclair." Walker made no mention of the extraordinary formation of the palpi; his diagnosis is very vague; and he placed the insect in the family Hydropsychidæ. In the Neuropterous portion of the 'Reise der Novara,' published in 1866, Dr. Brauer gave a very detailed and full description, with excellent figures, of the

same insect under the name *Anomalostoma alloneura* (pp. 15–20, pl. i. figs. 6 A, 6 B), worked out with that care for which he is so well known, the examples having been taken at Auckland by Frauenfeld.

Brauer evidently had suspicions that *Anomalostoma* might be identical with *Philanisus*, as is indicated at p. 16, and entered a protest against the adoption of Walker's name in case the insects should prove the same. It is not my intention here to enter into a discussion on the application of the rule of priority; suffice it to say that I agree with Brauer on principle, but sometimes doubt the practicability of his suggestions. He placed the insect in the family Rhyacophilidæ, in which he was followed by me in the Journ. Linn. Soc., Zool. vol. x. p. 214.

Now that we know the habits of the insect, it is clear that it cannot remain either amongst the Hydropsychidæ or the Rhyacophilidæ. In both these families the larvæ construct permanently *fixed* cases, not movable tubes. The anomalous structure of the palpi, and also the neuration, would suggest the Sericostomatidæ as a position; but in this family the maxillary palpi of the male are not only differently formed to those of the female, but have also fewer joints. In *Philanisus* the joints are five in both sexes; therefore I see no alternative other than to consider it an anomalous form of the family Leptoceridæ, to which the structure of the larva is not opposed. Perhaps the point on which it is most divergent from any other described species of this family is the structure of the apex of the abdomen in the female, which is produced into a very long, straight, pointed, horny ovipositor (fig. 5) (as in many Hydropsychidæ and Rhyacophilidæ, but more pronounced); in what way this structure may perhaps be in correlation with the presumably constant marine habitat remains to be seen.

Fig. 5.



Ovipositor of female.

The importance of Prof. Hutton's discovery rendered it desirable that a detailed account should be given so far as the materials would permit. Now that the connexion of this marine larva with *Philanisus* is proved, I hope he, or some other entomologist in New Zealand, may be able to give us fuller details; examples of the larvæ and pupæ preserved in alcohol are also desirable.

Postscript.

In the same package with the materials for the marine Caddis-fly Prof. Hutton forwarded specimens illustrating the economy of two other species of New-Zealand Trichoptera, from the Weka Pass, Canterbury.

(i.) *Helicopsyche.*—Numerous cases regularly formed, constructed of fine sand, $3\frac{1}{4}$–4 millim. in diameter by $1\frac{3}{4}$–$2\frac{1}{4}$ millim. high, with nearly three complete whorls. Some are empty; others contain larvæ and pupæ. Accompanying them were two female pupæ emerged from the cases, and ready for the final metamorphosis. So far as can be judged, the perfect insect should be congeneric with the species that have been reared in Europe and in North and South America. I refrain from bestowing names upon cases only *.

(ii.) Fixed cases, probably constructed by the larvæ of some unknown genus and species of Rhyacophilidæ, which should be of about the size of some of the smaller European species of *Rhyacophila.* The pupa is enveloped in a special cocoon, as is usual in the family, and does not agree with the genus *Rhyacophila* either in spurs or palpi. *Philanisus* having been removed from the family, the latter is now without any described representative in New Zealand. Of two cases, one is wholly composed of stony (? granitic) fragments; the other partially of similar fragments, partially of shells (of two or three species), and partially of the cases of the *Helicopsyche* referred to above.

Contributions to the Ornithology of New Guinea. By R. Bowdler Sharpe, F.L.S.—Part VIII.

[Read May 4, 1882.]

The present paper contains notes on collections made by Mr. A. Goldie in districts at the back of the Astrolabe range, in South-eastern New Guinea, and by Mr. Charles Hunstein on Normanby Island, on the south shore of the mainland of the China Straits, and on the banks of a river at the end of Milne Bay.

In a communication which I recently made to this Society (*antèa*, p. 317), I gave diagnoses of certain undescribed species of birds which had been forwarded to my friends Messrs. Osbert

* *Helicopsyche*-cases from New Zealand have long been in the British Museum, and have several times been alluded to by me in various published notes.

Salvin and F. DuCane Godman, by their correspondent Mr. Goldie; and I have again to thank them, as likewise Mr. Edward Gerrard, Jun., into whose hands the collections subsequently passed, for the favour of permitting me to make a complete list of their contents before their dispersal.

Two collections have been received from Mr. Goldie, the first being a very large one, full of interesting birds, though the number of novelties was comparatively small. The second was less in extent; but nevertheless contained a few species which were not in the former consignment. The point of most particular interest appears to me to be the discovery, in South-eastern New Guinea, of several birds hitherto supposed to be peculiar to the Arfak mountains, in the north-west part of the island, and the disappearance, in the Astrolabe range, of much of the Australian and Aru-Islands element, to which one has got accustomed in the collections made on the coast of South-eastern New Guinea. The nearest approach to the character of the present collections is afforded by the one obtained by Signor d'Albertis up the Fly River; and it would appear that the same type of bird-life extends down the entire mountain-range which traverses the length of New Guinea.

I have also thought it well to include in the present paper some notes on a collection of birds forwarded to the British Museum by Mr. Charles Hunstein, the discoverer of the wonderful *Clytoceyx rex* described by me in 1880. I had prepared a short report on Mr. Hunstein's collection, but was unable to finish it, owing to domestic affliction; and the collection was unfortunately dispersed before I was able to communicate to the Society a connected account of its contents. I have, however, carefully preserved the notes that I copied from Mr. Hunstein's MSS.; and, as several new localities are recorded, it seems worth while to publish them in the interests of geographical zoology.

Lastly, I cannot conclude this brief introduction without referring to the splendid work on the ornithology of Papuasia, which has been produced by Count Salvadori in 1881*. The great difficulty in determining species of New-Guinea birds has been rendered comparatively easy by the publication of Count Salvadori's volumes, which are remarkable for the erudition and care which has accompanied their production. I have followed his classification

* Published separately in two volumes, and also printed in Mem. R. Accad. Sci. Torino, ser. 2, tom. xxxiii., xxxiv.

throughout, and have adopted his nomenclature in nearly every instance.

NISAETUS MORPHNOIDES (*Gould*); *Sharpe, Cat. B.* i. p. 254. No. 198. Choqeri district. "Worrowa." [*A. G.*] New to the avifauna of New Guinea. The two birds sent are in fine plumage, with very dark streaks on the breast, and are apparently fully adult.

HALIAETUS LEUCOGASTER (*Gm.*). — Cuncuma leucogaster, *Salvad. Ornitologia della Papuasia e delle Molucche*, i, p. 7. Sent by Mr. Charles Hunstein, who shot one on the mainland in China Straits. "Iris dark yellowish brown; bill black; cere, eyelids, and feet orange."

HENICOPERNIS LONGICAUDA (*Garn.*); *Salvad. t. c.* i. p. 22. No. 96. Choqeri district. "Duna." Legs light stone-colour. [*A. G.*] Procured also by Mr. Hunstein in Milne Bay.

MACHÆRORHAMPHUS ALCINUS (*Westerm.*); *Salvad. t. c.* i. p. 25. No. 168. Morocco district. "Gigitokka." [*A. G.*]

BAZA REINWARDTII (*Müll. & Schl.*); *Salvad. t. c.* i. p. 26. No. 171. Morocco district. "Boraggi." The difference between some of the specimens now sent and *Baza subcristata* of Queensland consists principally in the larger size of the latter. In plumage one specimen of *B. Reinwardtii* seems to be identical with a Queensland skin. Milne Bay (*Hunstein*).

FALCO SEVERUS (*Horsf.*); *Sharpe, Cat. B. Brit. Mus.* i. p. 397. —Hypotriorchis severus, *Salvad. t. c.* i. p. 33. No. 201. Goldie's second collection. This is the first occurrence of the species in New Guinea; and I am glad to be able to record the fact, because I erroneously entered it some years ago as an inhabitant of New Guinea, not considering the fact that Salawati was an island of itself, and not an integral part of the great Papuan island.

HARPYOPSIS NOVÆ GUINEÆ, *Salvad.*; *id. t. c.* i. p. 40. No. 176. Choqeri district. "Duna." [*A. G.*] Mr. Goldie has sent two eggs said to be of this species, which are pure white. They came in the second collection, which had no list accompanying it; but the numbers on the eggs correspond with those attached to the birds. At the same time, the eggs look to me like those of a Hornbill, and not of a bird of prey. One specimen was sent by Mr. Hunstein, shot in a "small island off East Cape."

ASTUR POLIOCEPHALUS (*Gray*); *Salvad. t. c.* i. p. 45. No. 200. Choqeri range. "Yahato." [*A. G.*] A beautiful adult specimen in full plumage.

ASTUR ETORQUES, *Salvad.*—Urospizias etorques, *id. t. c.* i. p. 49. No. 199. Choqeri district. "Keki-Keki." [*A. G.*]

ASTUR LEUCOSOMUS, *Sharpe.*—Leucospizias leucosomus, *Salvad. t. c.* i. p. 42. Shot on Heath Island by Mr. Hunstein.

NINOX THEOMACHA (*Bp.*); *Salvad. t. c.* i. p. 79. No. 169. "Meoori." Morocco district. [*A. G.*]

NINOX ASSIMILIS, *Salvad. & D'Albert.*; *Salvad. Orn. Papuas.* i. p. 81. No. 110. Choqeri district. "Mamakaka." Eyes bright yellow; feet chrome-yellow. [*A. G.*] Though agreeing with the description given by Count Salvadori, the measurements are not the same, equalling, in fact, the dimensions of *N. rufistrigata*, the wing being 11 inches in length.

STRIX ARFAKI (*Schl.*); *Salvad. t. c.* i. p. 91. No. 197. Choqeri range. "Mamakaka." [*A. G.*] This form of Owl is not new to New Guinea, having been discovered in the Arfak Mountains by Dr. Meyer; and a specimen from Atam is in the Leiden Museum. As with the Arfak specimens, Mr. Goldie's bird is rather smaller than Australian ones, measuring only 10·9 inches in the wing. In his second collection was a remarkably dark-coloured individual, which I can hardly consider identical with the Australian bird.

STRIX DELICATULA, *Gould*; *Salvad. t. c.* i. p. 92. Shot by Mr. Hunstein at East Cape.

NASITERNA PUSILLA, *Ramsay*; *Salvad. t. c.* i. p. 128. No. 46. "Ciguri." Choqeri district. [*A. G.*] The differences between this little Parrot and *N. pusio*, Sclater, from the Solomon Islands, seem to me to be very slightly pronounced; but I do not like to judge decisively concerning the species, as our type of *N. pusio* was originally preserved in spirit, and the colours have doubtless somewhat faded.

APROSMICTUS CHLOROPTERUS, *Ramsay*; *Salvad. t. c.* i. p. 136. No. 37. Taburi district. "Kiula." Eyes yellow; legs dark grey. [*A. G.*]

CYCLOPSITTACUS COCCINEIFRONS, *Sharpe, anteà*, p. 318. No. 50. Morocco district. "Ciguri." [*A. G.*]

CYCLOPSITTACUS SUAVISSIMUS, *Sclater*; *Salvad. t. c.* i. p. 165. No. 45. Choqeri district. "Ciguri." [*A. G.*]

LORICULUS AURANTIIFRONS, *Schlegel*; *Salvad. t. c.* i. p. 171. A single specimen procured by Mr. Hunstein in Milne Bay appears to belong to this species. I have, however, no Arfak specimens with which to compare it, though I have little doubt as to the correctness of the identification.

GEOFFROYIUS ARUENSIS (*Gray*); *Salvad. t. c.* i. p. 175. No. 40. Morocco district. "Kiroki." [*A. G.*] Procured also at East Cape by Mr. Hunstein.

DASYPTILUS PESQUETI (*Less.*); *Salvad. t. c.* i. p. 216. No. 51. Morocco district. "Ugiava." Legs very dark slate-colour; eyes dark brown. Very rare bird, found on high ranges in couples. The call somewhat resembles that of the Black Cockatoo. [*A. G.*]

LORIUS HYPÆNOCHROUS, *Gray*; *Salvad. t. c.* i. p. 221. Mr. Hunstein sent a considerable series of this Lory, some of which, he states, were shot on an island south of the Woodlark Islands, some on East Cape, and some on the mainland in China Straits. He says that this bird resorts mostly to cocoanut-palms. "Iris yellowish brown; beak rosy red; cere snowy white; feet dark brown."

LORIUS ERYTHROTHORAX, *Salvad.*; *id. t. c.* i. p. 230. No. 38. Taburi district. "Tori." [*A. G.*]

EOS FUSCATA, *Blyth*; *Salvad. t. c.* i. p. 263. No. 39. Morocco district. "Arrero." Eyes pink; legs dark. [*A. G.*]

TRICHOGLOSSUS MASSENA, *Bp.*; *Salvad. t. c.* i. p. 288. No. 53. Morocco district. "Kifon." [*A. G.*] Shot at East Cape by Mr. Hunstein. "Iris yellow."

TRICHOGLOSSUS GOLDIEI, *Sharpe, anteà*, p. 317. No. 52. Morocco district. "I-I-hawa."

Adult male. General colour above green, the hind neck mottled with yellow edges to the feathers, extending a little on the mantle; wing-coverts like the back; primary-coverts and quills dusky blackish, externally brighter green; the secondaries like the

back; tail-feathers greenish brown, edged with bright green like the back, the tips fringed with yellow; forehead and sinciput scarlet, tending towards a point in the middle of the crown; from behind the eye a broad purplish-blue band extends round the occiput to behind the opposite eye; the nape-feathers brown, washed with lilac and faintly streaked with dull scarlet; lores, sides of face, and ear-coverts lilac-red, with a bluish shade along the upper margin of the latter; below the eye the feathers rather lighter in colour and having indistinct tiny streaks of dull blue; under surface of body yellowish green, streaked with dark green down the centre of the feathers, more narrowly on the under tail-coverts; under wing-coverts like the breast and streaked with dark green in the same manner; quills dusky below, all but the outer primaries oily yellow for two thirds of the inner web, forming a conspicuous diagonal patch across the wing when uplifted. Total length 6·5 inches, culmen 0·6, wing 4·2, tail 3·1, tarsus 0·5.

The type first described was either a female or a young male, as in the second collection Mr. Goldie has sent two fully adult birds, evidently males in full plumage. I have therefore given a more complete description above.

CORIPHILUS WILHELMINÆ (*Meyer*); *Salvad. t. c.* i. p. 302. No. 42. Morocco district. "Ciguri."

In the first collection two specimens were sent, which looked so different from Gould's plate of *C. Wilhelminæ*, that I was at first disposed to consider them as belonging to a distinct species. In the second collection there was an adult male, which leaves no doubt of the species; so that this pretty little Parrakeet extends from the Arfak Mountains down to the Astrolabe range.

Both the specimens first sent by Mr. Goldie appear to be immature males. One has the occipital streaks purplish blue and very indistinct, has no trace of red on the lower back, and the streaks on the breast emerald-green. In the second the striæ on the breast are pale yellow, and there is a slight appearance of scarlet on the back; but there is no indication of any streaks on the occiput at all.

CORIPHILUS SUBPLACENS, *Sclater*; *Salvad. t. c.* i. p. 310. No. 41. Taburi district. "Keci." [*A. G.*]

CHARMOSYNOPSIS PULCHELLA (*Gray*); *Salvad. t. c.* i. p. 317. No. 49. Morocco district. "Oilama." [*A. G.*]

CHARMOSYNA JOSEPHINÆ (*Finsch*); *Salvad. t. c.* i. p. 325. No. 2. Morocco district. "Divu." [*A. G.*]

Two skins of native preparation in Mr. Goldie's collection. The species was previously known only from Arfak. "The feathers from the tail have been frequently obtained along the coast. The natives said that the bird was only to be obtained at a considerable distance from Morocco inland on the mountains." [*A. G.*]

CACOMANTIS ASSIMILIS (*Gray*); *Salvad. t. c.* i. p. 337. No. 115. Choqeri district. "Quoitatirito." [*A. G.*]

CACOMANTIS CASTANEIVENTRIS, *Gould*; *Salvad. t. c.* i. p. 334. No. 118. Morocco district. "Quoitatirito." [*A. G.*]

LAMPROCOCCYX MEYERII (*Salvad.*); *Salvad. t. c.* i. p. 346. No. 116. "Barrumgbatte." Morocco district. [*A. G.*] Only known before from the Arfak Mountains.

EUDYNAMIS RUFIVENTER (*Less.*); *Salvad. t. c.* i. p. 368. No. 119. Morocco district. "Gididda." [*A. G.*]

New to South-eastern New Guinea. Only a male is sent, but the dimensions refer it to the present species.

SCYTHROPS NOVÆ-HOLLANDIÆ, *Lath.*; *Salvad. t. c.* i. p. 372. Shot by Mr. Hunstein on Dinner Island. "Iris yellow-brown; feet grey; base of bill and ring round eyes red."

POLOPHILUS NIGRICANS, *Salvad.*; *id. t. c.* i. p. 390.

Shot at East Cape by Mr. Hunstein. "Iris brown; feet black."

RHYTIDOCEROS PLICATUS (*Penn.*); *Salvad. t. c.* i. p. 392. No. 97. Choqeri district. "Ure." [*A. G.*]

Mr. Hunstein procured this species on the mountain-ranges of East Cape. "Iris yellowish red; eyelids rosy red; skin from the base of the bill and under the throat bluish white."

MEROPS ORNATUS, *Lath.*; *Salvad. t. c.* i. p. 401. East Cape (*Hunstein*).

ALCEDO ISPIDOIDES, *Less.*; *Salvad. t. c.* i. p. 408. East Cape, and on the mainland in China Straits (*Hunstein*).

ALCYONE LESSONI, *Cass.*; *Salvad. t. c.* i. p. 410. No. 69. Taburi district. "Domoya." [*A. G.*] Procured also in Milne Bay by Mr. Hunstein.

CEYX SOLITARIA, *Temm.*; *Salvad. t. c.* i. p. 420. No. 70. Taburi district. "Kikkebedi." [*A. G.*] Milne Bay (*Hunstein*).

TANYSIPTERA MICRORHYNCHA, *Sharpe.*—T. galatea, pt., *Salvad. t. c.* i. p. 438. No. 66. Morocco district. "Dogeri." [*A. G.*] East Cape (*Hunstein*).

TANYSIPTERA SALVADORIANA, *Ramsay*; *Salvad. t. c.* i. p. 453. No. 67. Morocco district. "Mimiori." [*A. G.*]

TANYSIPTERA DANÆ, *Sharpe, Ann. & Mag. Nat. Hist.* (5) vi. p. 231 (1880).—T. nympha, juv., *Ramsay, Proc. Linn. Soc. N. S. W.* iv. p. 467 (1879). No. 61. Taburi district. "Mimiori." Eyes dark; legs orange. [*A. G.*]

Mr. Charles Hunstein, who discovered this species, sent a large series procured on the ranges in Milne Bay and China Straits. "Iris red-brown; feet red."

HALCYON MACLEAYII, *Jard. & Selby.*—Cyanalcyon Macleayii, *Salvad. t. c.* i. p. 465. No. 71. Taburi district. "Kiokereri." [*A. G.*]

HALCYON SAUROPHAGA, *Gould.*—Sauropatis saurophaga, *Salvad. t. c.* i. p. 468. Heath Island. Iris dark brown; feet grey. (*Hunstein.*)

HALCYON SANCTUS.—Sauropatis sancta (*Vig. & Horsf.*); *Salvad. t. c.* i. p. 476. East Cape and on the mainland in China Straits (*Hunstein*).

SYMA TOROTORO, *Less.*; *Salvad. t. c.* i. p. 482. No. 63. Taburi district. "Kororro." [*A. G.*] Milne Bay. Iris brown; feet red. (*Hunstein.*)

DACELO GAUDICHAUDI, *Quoy & Gaim.*—Sauromarpatis Gaudichaudi, *Salvad. t. c.* i. p. 487. No. 65. Morocco district. "Kiokereri." [*A. G.*] East Cape (*Hunstein*).

CLYTOCEYX REX, *Sharpe, Ann. & Mag. Nat. Hist.* (5) vi. p. 231 (1880); *Gould, B. New Guinea*, part xii. Several specimens of this remarkable Kingfisher were in Mr. Goldie's collection from the Taburi district.

MELIDORA MACRORHINA (*Less.*); *Salvad. t. c.* i. p. 500. No. 63. Taburi district. "Varrara Kin-Kin." [*A. G.*] East Cape. Feet red. (*Hunstein.*)

PODARGUS OCELLATUS, *Quoy & Gaim.*; *Salvad. t. c.* i. p. 517. No. 111. "Ennubers." Night-bird. Morocco district. Four specimens, all differing in plumage, three rufescent and one dark.

ÆGOTHELES BENNETTI, *Salvad. & D'Alb.*; *Salvad. t. c.* i. p. 525. No. 86. "Bowshukker." Taburi district. [*A. G.*]

MACROPTERYX MYSTACEA (*Less.*); *Salvad. t. c.* i. p. 537. No. 137. Morocco district. "Oiloya." [*A. G.*] East Cape. Iris umber-brown; beak and feet black. (*Hunstein.*)

COLLOCALIA ESCULENTA (*L.*); *Salvad. t. c.* i. p. 540. No. 190. Choqeri district. "Winbiago." [*A. G.*]

COLLOCALIA FUCIPHAGA (*Thunb.*); *Salvad. t. c.* i. p. 544. No. 191. Choqeri district. "Winbiago." [*A. G.*]

HIRUNDO JAVANICA, *Sparrm.*; *Salvad. op. cit.* ii. p. 3. No. 165. Morocco district. "Urubiago." [*A. G.*]

PELTOPS BLAINVILLEI (*Less. & Garn.*); *Salvad. op. cit.* ii. p. 8. No. 112. Choqeri district. "Torri-iba." Eyes deep crimson; legs black. [*A. G.*]

MONARCHA MELANOPSIS (*Vieill.*); *Salvad. t. c.* ii. p. 16. No. 100. Choqeri district. "Nageoa." [*A. G.*]

Agrees with the description of Australian birds given in my Catalogue (vol. iv. p. 430), and with specimens in the Museum from the continent of Australia and South-eastern New Guinea. Mr. Goldie does not seem to have considered it distinct from *M. periophthalmicus*; and until we know the coloration of both sexes of the latter bird, it is possible to imagine that it may have a female indistinguishable from the male of *M. melanopsis* of Australia. I think this is scarcely likely to be the case; and as we know that *M. melanopsis* is by no means uncommon in South-eastern New Guinea, it is most likely that Mr. Goldie procured both species in the same locality, but did not notice the differences between them.

MONARCHA PERIOPHTHALMICUS, *Sharpe, antea*, p. 318. No. 100. "Nageoa." Morocco district. [*A. G.*]

At first sight this species would appear to be the same as *M. frater* of Sclater from the Arfak Mountains; but in the description of the type given by me in my 'Catalogue,' the feathers round and in front of the eye are described as "*hoary white*, the black colour *confined to the chin and upper part of the throat, lores, and feathers at the angle of the mouth.*"

In the species from the Astrolabe Mountains the whole of the feathers round the eye and below it are also black. I add a detailed description:—General colour above pearly grey, a little

darker on the upper tail-coverts, which have concealed black bases; lesser and inner median and greater coverts pearly grey like the back; bastard-wing, primary-coverts, as well as the outer median and greater series and the quills black, only the innermost secondaries externally pearly grey; tail-feathers black; forehead and sinciput, lores, fore part of cheeks, feathers below the eye, and a broad ring round the eye black; chin and upper throat black; lower throat, fore neck, and chest pearly grey, as also the sides of the neck; remainder of under surface of body as well as the thighs and under tail-coverts, also the axillaries and under wing-coverts, cinnamon-buff; quills blackish below. Total length 5·5 inches, culmen 0·75, wing 3·4, tail 2·75, tarsus 0·75.

It is possible that, if the specimens could be compared, other differences would appear between *M. frater* and the present species, as I see that I have described the former as having a *broad band of blue-black across the forehead*. In *M. periophthalmicus* the fore part of the crown is also black.

PIEZORHYNCHUS GUTTULATUS (*Garn.*); *Sharpe, Cat. B.* iv. p. 422.—Monarcha guttulatus, *Salvad. t. c.* ii. p. 22. No. 92. Choqeri district. "Haw-hawduridu." Legs black. [*A. G.*]

PIEZORHYNCHUS CHALYBEOCEPHALUS (*Garn.*).—Monarcha chalybeocephalus, *Salvad. t. c.* ii. p. 30. East Cape (*Hunstein*).

PIEZORHYNCHUS ARUENSIS (*Salvad.*); *Sharpe, Cat. B.* iv. p. 428.—Monarcha aruensis, *Salvad. op. cit.* ii. p. 40. No. 139. Morocco district. "Iriacowowo." [*A. G.*]

ARSES ARUENSIS, *Sharpe*; *Salvad. t. c.* ii. p. 45. In Mr. Goldie's second collection. East Cape (*Hunstein*).

RHIPIDURA THRENOTHORAX, *S. Müll.*; *Salvad. t. c.* ii. p. 54.—Rhipidura ambusta, *Ramsay*; *Salvad. t. c.* p. 55. No. 164. Morocco district. "Owasush." Found generally on ground. [*A. G.*]

Count Salvadori has already suggested that *R. ambusta* of Ramsay would prove to be *R. threnothorax*, and on comparing the specimens in the Museum I find this to be the case.

RHIPIDURA SETOSA (*Quoy & Gaim.*); *Salvad. t. c.* ii. p. 61 No. 192. Choqeri district. "Neberakikki." [*A. G.*]

RHIPIDURA HYPERYTHRA (*Gray*); *Salvad. t. c.* ii. p. 65. No. 172. "Urabiagga." Morocco district. [*A. G.*] A new locality for the species.

MONACHELLA MUELLERIANA (*Schl.*); *Sharpe, Cat. B. Brit. Mus.* iv. p. 83.—M. saxicolina, *Salvad. t. c.* ii. p. 83. No. 167. Morocco district. "Jada." Found with *Grallina Bruijni.* [*A. G.*]

PŒCILODRYAS ALBIFACIES, *Sharpe, anteà,* p. 318. No. 90. Choqeri district. "Iddimattamatta." Legs yellow. [*A. G.*]

Adult. General colour above olive-green, with a concealed spot of silky white on the sides of the rump; lesser and median wing-coverts like the back; primary-coverts and greater series dusky brown, edged with olive-green, the latter slightly tinged with rufous-brown near the tips; quills dusky brown, externally olive, a little more yellow in colour than the back; tail-feathers light brown edged with olive, and having a small tip of ashy white at the end of the inner web; forehead blackish, extending over the eye; top of head dark slaty grey, with blackish shaft-streaks to the feathers, which are also very faintly tinged with olive; lores, feathers in front of the eye impinging on the forehead, feathers above and around the eye, as well as the space below the eye, pure white; ear-coverts slaty black; cheeks and chin white, faintly washed with yellow; throat and under surface of body bright yellow, the sides of the breast and flanks olive-greenish, a tinge of which is also on the centre of the breast; axillaries bright yellow; under wing-coverts white washed with yellow, with a dusky patch near the edge of the wing which is also yellow; quills ashy brown below, whitish along the edge of the inner web. Total length 4·5 inches, culmen 0·55, wing 2·85, tail 1·9, tarsus 0·8.

MICRŒCA FLAVOVIRESCENS (*Gray*); *Salvad. t. c.* ii. p. 92. No. 143. Morocco district. "Bimadamada." [*A. G.*]

PSEUDOGERYGONE PALPEBROSA (*Wallace*); *Sharpe, Cat. B.* iv. p. 230.—Gerygone palpebrosa, *Salvad. t. c.* ii. p. 96. No. 103. Choqeri district. "Chioile." [*A. G.*] Hitherto known from the Aru Islands and the Arfak Mountains in North-western New Guinea.

ÆTHOMYIAS GUTTATA, sp. n. No. 179. Choqeri district. "Domida." [*A. G.*]

General colour above olive-green, a little clearer and lighter on the lower back and rump, the head rather more dusky olive; least wing-coverts like the back, the greater series dull ashy brown, externally washed with olive-green; quills dull ashy brown,

externally edged with olive-green, inclining to olive-brown on the margins of the primaries; upper tail-coverts olive-brown; quills brown, externally edged with olive-brown, with a slight subterminal shade of blackish; lores whitish, tinged with brown at the base of the forehead; eyelid and ear-coverts light brown, with indistinct paler shaft-lines on the latter; cheeks and throat white; the remainder of the under surface of body pale yellow; the fore neck and chest washed with dusky, the sides of the breast and flanks dull olive-green, the breast rather broadly streaked with dusky brown; the cheeks mottled with dusky tips to the feathers, the throat covered with distinct ovate blackish spots; thighs dull olive; under tail-coverts pale yellow, with pale centres of dusky brown; under wing-coverts and axillaries olive-greenish; quills ashy brown below, ashy whitish along the edge of the inner web; bill light brown, paler on the lower mandible; legs dark brown (in skin). Total length 4·2 inches, culmen 0·55, wing 2·4, tail 1·9, tarsus 0·75.

This species is very like *Æ. spilodera* (Gray), with the type of which I have compared it. A young bird described by me in the Brit. Mus. Cat. (iv. p. 271) resembles *Æ. guttata* in having the head like the back, but has no spots on the throat.

Æ. spilodera has the head blackish brown, as also the feathers of the eye and ear-coverts, whereas in *Æ. guttata* the head is olive-brown, only a little darker than the back, and the ear-coverts and feathers round the eye are light brown; the bill, too, is light horn-brown, and the legs brown, not yellow as in *Æ. spilodera*.

Malurus alboscapulatus, *Meyer*; *Salvad. t. c.* ii. p. 119. No. 193. Choqeri district. "Metotorri." [*A. G.*]

Artamides cæruleogriseus (*Gray*); *Sharpe, Cat. B.* iv. p. 15. —Graucalus cæruleogriseus (*Gray*); *Salvad. t. c.* ii. p. 122. In Mr. Goldie's second collection.

Graucalus hypoleucus, *Gould*; *Salvad. t. c.* ii. p. 136. No. 87. Taburi district. "Vija-vija." [*A. G.*]

Graucalus axillaris, *Salvad.*; *id. t. c.* ii. p. 138. Nos. 80, 88. Taburi district. "Shorara." [*A. G.*] A pair of this interesting species, hitherto known only from the Arfak Mountains.

Edoliisoma poliopsa, *Sharpe, anteà*, p. 318. No. 145. Morocco district. "Nagioa." [*A. G.*]

General colour above dark chestnut, more dusky on the mantle and upper back, where the feathers are obscurely dark-shafted;

the scapulars like the mantle; the lower back, rump, and upper tail-coverts lighter and more maroon-brown; two centre tail-feathers chestnut, with a subterminal mark of blackish; remainder of tail-feathers black, tipped with chestnut, increasing in extent towards the outermost, which is also chestnut along the outer web; wing-coverts chestnut; bastard-wing and primary-coverts black; quills black, externally chestnut, broader on the secondaries, the innermost of which are entirely chestnut; entire head and nape as well as the sides of the face and ear-coverts slaty grey, blackish on the lores and on extreme base of forehead and below the eye, the ear-coverts also blackish; fore part of cheeks and chin ashy grey; hinder cheeks and throat chestnut barred with grey; remainder of under surface rich chestnut, becoming paler towards the flanks and under tail-coverts; under wing-coverts like the breast, as also the axillaries; quills black below, rufous along the inner web. Total length 6·8 inches, culmen 0·8, wing 4·2, tail 3·4, tarsus 0·85.

Apparently only females of this new species have been sent; and on comparing them with the hen of *E. schisticeps*, it is evident that they do not belong to the same species, as in the bird now sent the ear-coverts and cheeks are dark ashy grey instead of being rufous. I have compared them carefully with our specimens in the British Museum.

EDOLIISOMA MELAS (*Müll.*); *Salvad. t. c.* ii. p. 143. No. 140 [♂ ad.]. Morocco district. "Nagioa." Nos. 81 [♂ juv.], 82 [♀ ad.]. Taburi district. "Toato." [*A. G.*]

LALAGE KARU (*Less.*); *Salvad. t. c.* ii. p. 161. No. 117. Choqeri district. "Dellorrome." [*A. G.*] The characters mentioned by Count Salvadori seem to be constant; and it is perhaps better to separate *L. karu* from *L. leucomela*.

CAMPOCHÆRA SLOETII (*Schl.*); *Salvad. t. c.* ii. p. 165. No. 120. Choqeri district. "Jannao." [*A. G.*]

ARTAMUS LEUCOGASTER (*Val.*); *Salvad. t. c.* ii. p. 167. No. 125. Morocco district. "Ya-ito." [*A. G.*]

CHIBIA CARBONARIA (*S. Müll.*); *Sharpe, Cat. B.* iii. p. 238.—Dicruropsis carbonaria, *Salvad. t. c.* ii. p. 177. No. 83. Taburi district. "Kekkacino." [*A. G.*]

CHÆTORHYNCHUS PAPUENSIS, *Meyer*; *Salvad. t. c.* ii. p. 183. No. 102. Choqeri district. "Kecio." [*A. G.*]

With much searching I found a little tuft of white feathers concealed on one shoulder in one specimen sent. Can it be that the white shoulder-patch, which, it will be remembered, was at first entirely overlooked by Dr. Meyer in his original description and by me in the 'Catalogue of Birds,' is only a seasonal ornament?

In the second example the white spot is a little plainer.

CRACTICUS MENTALIS, *Salvad. & D'Alb.*; *Salvad. t. c.* ii. p. 189. No. 134. In Mr. Goldie's collection.

GRALLINA BRUIJNI, *Salvad.*; *id. t. c.* ii. p. 191. No. 166. Morocco district. "Tada."

These birds are found flying about creeks and hopping amongst stones. They seem to feed on insects obtained there. [*A. G.*]

Count Salvadori seems to be acquainted with the hen bird only. The males sent by Mr. Goldie differ in having the entire breast black, leaving only the abdomen and under tail-coverts pale creamy buff. The lores and sides of face are entirely black, leaving only a streak behind the eye and a patch on the sides of the neck white. This difference in the colour of the sexes is apparently usual in the genus *Grallina*.

RHECTES CRISTATUS, *Salvad.*; *id. t. c.* ii. p. 202. No. 194. Choqeri district. "Chobea." [*A. G.*]

RHECTES DICHROUS, *Bp.*; *Salvad. t. c.* ii. p. 195. No. 85. Morocco district. "Queoco." This bird during the process of skinning causes a violent sneezing fit. It is the only bird we have yet found that the natives will not eat. [*A. G.*] Mainland of China Straits (*Hunstein*).

PSEUDORECTES FERRUGINEUS (*S. Müll.*); *Sharpe, Cat. B.* iii. p. 287.—Rhectes ferrugineus, *Salvad. t. c.* ii. p. 203. No. 128. Morocco district. "Towolo." [*A. G.*] Mainland in China Straits (*Hunstein*).

PINAROLESTES RUFIGASTER (*Gould*); *Sharpe, Cat. B.* iii. p. 296. No. 91. Choqeri district. "Ebbote." Legs slate-colour. [*A. G.*]

PACHYCEPHALOPSIS POLIOSOMA, *Sharpe, antea*, p. 318. No. 173. Taburi district. "Uradaroro." [*A. G.*]

Above uniform dull ashy grey, the head slightly duller; wing-coverts like the back; quills and tail-feathers rather browner; lores and eyebrows as well as the ear-coverts ashy, the feathers before the eye and a streak below the latter black; under surface

of body ashy grey, with the lower abdomen and the under tail-coverts slightly whitish; throat whitish brown, the sides washed with ashy; cheeks whitish, lighter than the throat, and forming an indistinct moustache; under wing-coverts and axillaries ashy; quills sepia-brown below, edged with pale brown along the inner web. Total length 6·3 inches, culmen 0·8, wing 4·2, tail 2·5, tarsus 1·2. Of the same form as *P. hattamensis*, but very different in colour.

PACHYCEPHALA SOROR, *Sclater*; *Salvad. t. c.* ii. p. 222. No. 177. Choqeri district. "Ehito." [*A. G.*] Found plentifully in the Arfak Mountains, but new to South-eastern New Guinea.

PACHYCEPHALA DUBIA, *Ramsay*; *Salvad. t. c.* ii. p. 228. No. 144. Morocco district. "Cribata." [*A. G.*] This species seems to be perfectly distinct, and to agree thoroughly with the characters laid down by Salvadori in his work above quoted.

PACHYCEPHALA HYPERYTHRA, *Salvad.*; *id. t. c.* ii. p. 232. No. 99. Choqeri district. "Godomeda." [*A. G.*] New to South-eastern New Guinea, having only been found before in the Arfak Mountains.

PACHYCARE FLAVOGRISEA (*Meyer*); *Salvad. t. c.* ii. p. 238. No. 126. Morocco district. "Iffifanafo." [*A. G.*]

I have compared the two specimens sent by Mr. Goldie with an Arfak bird, and find the two identical. It was previously only known from the Arfak Mountains.

HERMOTIMIA ASPASIA (*Less.*); *Salvad. t. c.* ii. p. 247. No. 149. Morocco district. "Chomadubu." [*A. G.*] East Cape (*Hunstein*).

DICÆUM RUBROCORONATUM, *Sharpe*; *Salvad. t. c.* ii. p. 276. No. 152. Morocco district. "Borrioavia." [*A. G.*]

MELANOCHARIS BICOLOR, *Ramsay*; *Salvad. t. c.* ii. p. 283. No. 95. Choqeri district. "Chomadubu." Legs black. [*A. G.*]

Count Salvadori does not seem to be convinced about the distinctness of this southern species; but both the adult males now sent have the white on the under tail-coverts as mentioned by Mr. Ramsay.

OREOCHARIS ARFAKI (*Meyer*); *Salvad. t. c.* ii. p. 289. No. 141. Morocco district. "Inacawawo." Legs dark drown. [*A. G.*]

Only known before from the Arfak Mountains. The single

specimen sent by Mr. Goldie is a fully adult bird, which agrees exactly with the figure in Gould's 'Birds of New Guinea' (part iv.). It does not agree so well with Count Salvadori's description, which appears to me to be taken from a slightly immature bird.

MYZOMELA NIGRITA, *Gray*; *Salvad. t. c.* ii. p. 291. No. 150. Choqeri district. "Chomadubu." [*A. G.*] East Cape (*Hunstein*).

MYZOMELA ROSENBERGII, *Schl.*; *Salvad. t. c.* ii. p. 294. No. 151. Choqeri district. "Chomadubu." [*A. G.*]

An adult and immature female are sent. Many specimens are enumerated by Count Salvadori from the Arfak Mountains; and he also mentions that two skins of native preparation were procured by Signor D'Albertis from the mountains near Hall Bay. These skins, though mutilated, were pronounced by Count Salvadori to be identical with others from North-western New Guinea, and the same may be said of the present birds.

MYZOMELA OBSCURA, *Gould*; *Forbes, P. Z. S.* 1879, p. 268; *Salvad. t. c.* ii. p. 303. East Cape (*Hunstein*).

MELILESTES ILIOLOPHUS, *Salvad.*; *id. t. c.* ii. p. 316. No. 104. Choqeri district. "Biriuta." [*A. G.*]

General colour above dull olive-green, the head a little duller than the back; feathers of the lower back and rump very long and silky, and a little lighter than the rest of the back; wing-coverts like the back, the primary-coverts and quills dusky brown, edged with olive-green like the back, the secondaries more broadly; tail dusky black; lores and feathers round the eye ashy olive; ear-coverts lighter olive; under surface of body very pale yellowish, ashy on the cheeks and throat; sides of the body with long silky plumes of paler yellow; under tail-coverts like the abdomen, and washed with pale olive-green; axillaries light yellow like the sides of the body; under wing-coverts light ashy brown, washed with yellowish olive; quills dusky below, whitish along the edge of the inner web. Total length 3·9 inches, culmen 0·85, wing 2·7, tail 1·45, tarsus 0·85.

MELILESTES MEGARHYNCHUS (*Gray*); *Salvad. t. c.* ii. p. 313. No. 132. Morocco district. "Cheta." Eyes light red; legs dark [*A. G.*] Procured by Signor D'Albertis on the Fly River.

The bird sent by Mr. Goldie has a slight streak of yellowish

white, as well as the eyelid and a spot at the base of the cheeks. This yellowish eyelid may be the remains of young plumage, though Count Salvadori gives it as a characteristic of the adult. In the Museum we have a large series of this species; and the birds without the above characters seem to me to be the older ones.

MELILESTES POLIOPTERUS, *Sharpe, anteà*, p. 318. No. 153. Choqeri district. "Bererita." [*A. G.*]

General colour above green, the whole of the crown and nape dark slaty grey; wing-coverts slaty grey; quills dusky, externally slaty grey, rather lighter along the edge of the primaries, the secondaries with a very faint olive tint on the outer webs; tail-feathers dusky, externally edged with slaty grey, and having a small white spot at the tip of the inner web; lores, sides of face, and ear-coverts dull slaty grey, with a slight wash of green; under surface of body olive-yellow, the chin dusky grey washed with yellow, the lower throat bright yellow; thighs ashy, washed with yellow; under tail-coverts yellow, ashy grey along the centre; under wing-coverts and axillaries white, the latter washed with yellow; quills dusky brown, edged with white along the inner web. Total length 4·4 inches, culmen 1·2, wing 2·85, tail 1·55, tarsus 0·7.

MELIDECTES TORQUATUS, *Sclater*; *Salvad. t. c.* ii. p. 319. No. 130. Morocco district. "Ugirru."

Eyes dark brown; legs bluish slate-colour; bare patch above eye bright yellow, deepening to rich orange around the eye. The wattles under the eye are also edged orange. The skin at the junction of the beak with the head is flesh-colour. [*A. G.*]

Agrees with the figure given by Gould (B. N. Guin. part iv.). The species was only known before from the Arfak Mountains.

PTILOTIS ANALOGA (*Reichenb.*); *Salvad. t. c.* ii. p. 327. No. 148. Morocco district. "Eaga." Legs dark slate. [*A. G.*]

PTILOTIS MARMORATA, *Sharpe, anteà*, p. 319. No. 146. Morocco district. "Eaga." Legs dark. [*A. G.*]

General colour above dusky brown, the feathers margined with olive, rather lighter on the head, which has a mottled appearance; on the forehead and over the eye a slight shade of ashy; wing-coverts like the back, but the outer median and greater coverts edged with paler olive, inclining to whity brown near the tips;

quills and tail dusky, externally edged with yellowish olive, the tail-feathers margined with light rufous on the inner web; sides of face and ear-coverts dusky blackish, with a slight shade of silvery whitish on the ear-coverts, and a streak of dull white from behind the lores under the eye; cheeks dusky blackish, with a slight indication of ashy tips to the feathers; a narrow malar streak of dull yellowish white; throat yellowish white, mottled with dusky bases to the feathers; remainder of under surface of body ashy, the feathers tipped with a white bar and slightly washed with olive; the whole appearance of the under surface mottled, excepting on the lower flanks, which are uniform olive; thighs dusky; under tail-coverts light rufous with dusky bases, the outer ones externally yellowish white, mottled with dusky bases to the feathers; axillaries pale olive-yellowish; under wing-coverts light rufous-buff; quills dusky below, pale rufous along the inner web. Total length 7 inches, culmen 1·05, wing 3·8, tail 3·7, tarsus 1·05.

This new species is very close to *P. cinerea*, but is recognized by the whitish edging to the breast-feathers, which gives it a mottled appearance.

PLECTORHYNCHA FULVIVENTRIS, *Ramsay, Proc. Linn. Soc. N. S. Wales*, 1882, p. 718. No. 202. In Mr. Goldie's second collection.

Mr. Ramsay has had the courtesy to send me a proof of a paper recently published by him in the 'Proceedings of the Linnean Society of New South Wales,' which, he informs me, was read on the 31st of August, 1881, and published on the 11th of January, 1882; and I find the description of the present species, which I was about to publish as new. Considering the mass of synonymy which one has to wade through now-a-days in the preparation of such a work as the 'Catalogue of Birds,' Mr. Ramsay's action in letting us know as early as possible of the publication of his new species cannot be too highly appreciated, as an unnecessary name has been saved thereby; and it has hitherto been a great drawback to describing many New-Guinea species which have been in my hands, to think that probably at the same moment Mr. Ramsay has received a similar consignment, and is at the time bestowing a second title upon them. The difficulty is greatly increased by the fact that we have no positive information as to the real date of publication of the 'Proceedings of the Linnean

Society of New South Wales, and thus questions of priority of nomenclature often arise.

XANTHOTIS POLYGRAMMA (*Gray*); *Salvad. t. c.* ii. p. 343. No. 101. Choqeri district. "Baromori." [*A. G.*] Known from the Arfak Mountains, and procured by Signor D'Albertis on the Fly River.

XANTHOTIS FILIGERA (*Gould*); *Salvad. t. c.* ii. p. 344. No. 131. Morocco district. "Tamorri." Bare patch around eye flesh-colour. [*A. G.*] A large series of this species was obtained by Signor D'Albertis on the Fly River.

PHILEMONOPSIS MEYERI, *Salvad.*; *id. t. c.* ii. p. 350. No. 93. Choqeri district. "Tamorri." Legs dark grey. [*A. G.*] Many specimens of this species were collected on the Fly River by Signor D'Albertis.

ZOSTEROPS DELICATULA, *Sharpe, anteà*, p. 318. No. 142. Morocco district. "Cuja." [*A. G.*]

PITTA MACKLOTI, *Temm.*; *Salvad. t. c.* ii. p. 395. No. 196. Choqeri district. "Torra." [*A. G.*] East Cape, Milne Bay (*Hunstein*).

BRACHYPTERYX MURINA (*Temm.*); *Salvad. t. c.* ii. p. 406. No. 106. Choqeri district. "Eheto." Ground-bird. [*A. G.*]

In the British Museum are two specimens, one from New Guinea and the other from Waigiou, both collected by Wallace. On comparing the specimen now sent by Mr. Goldie, the richness of the colouring of the underparts is very apparent in the latter, being of a rich vinous brown, a shade of which pervades the throat also. I am not satisfied, however, that this could be reckoned on as a specific character, for the twenty years that have elapsed since Mr. Wallace's skins were prepared may have caused the colours to fade a little, and I can find no other points of difference.

EUPETES PULCHER, *Sharpe, anteà*, p. 319. No. 89. Taburi district. "Show-show." Ground-bird. Legs black; eyes dark.

Adult male. General colour above rich chestnut, including the hinder head and neck, mantle and back; top of head duller rufous-brown; lower back, rump, and upper tail-coverts blue; scapulars blue, washed with light reddish, with paler shaft-lines, indications of which are also seen on the feathers of the mantle; wing-

coverts bright blue; bastard-wing feathers black; primary-coverts black, edged with blue; quills black, the primaries slightly, the secondaries more plainly washed with blue externally, the innermost with olive-brown; tail dull blue, brighter blue on the edges of the feathers; base of forehead and lores black, succeeded by a band of dull blue across the forehead, and forming a distinct eyebrow, which extends to behind the ear-coverts, which are black; cheeks, lower portion of ear-coverts, and entire throat pure white, narrowly edged with a line of black; remainder of under surface bright blue; the under tail-coverts blue, with a broad spot of black at the ends; under wing-coverts and axillaries blackish, the outer ones washed with blue; quills ashy blackish below. Total length 9 inches, culmen 1·05, wing 3·7, tail 4·3, tarsus 1·35.

Adult female. Differs from the male in having the entire upper surface chestnut, without any blue; the chestnut colour is, however, much duller than in the male, except on the lower back and rump; crown of head dusky brown; wings as in the male; tail dull blue, the two centre feathers brown; lores and plumes at base of nostril black, surmounted by a narrow line of rufous, washed with blue above the eye, and inclining to whitish above the ear-coverts; cheeks and throat white; remainder of under surface blue as in the male. Total length 8·5 inches, culmen 1, wing 3·65, tail 3·9, tarsus 1·3.

Young male. Like the old female, but more dusky on the back, and showing some blue feathers interspersed amongst the rufous plumes of the rump.

Hab. Astrolabe Mountains, South-eastern New Guinea (*coll. A. Goldie*).

This new species is closely allied to *Eupetes castanonotus* of Salvadori ('Orn. del. Papuasia,' ii. p. 411); but that bird is described as having the head chestnut like the back, whereas in *E. pulcher* it is decidedly dusky in colour. Again, in Count Salvadori's description *E. castanonotus* is said to have a black band from the lores, surrounding the white throat and widening out on the breast. There is only a narrow black edging to the throat in the bird from South-eastern New Guinea.

CINCLOSOMA AJAX (*Temm.*); *Salvad. t. c.* ii. p. 416. No. 195. Choqeri district. "Ugato." [*A. G.*] Shot in Milne Bay. Iris yellow; feet flesh-coloured (*Hunstein*).

DRYMŒDUS BECCARII, *Salvad.*; *id. t. c.* ii. p. 417. No. 107. Choqeri district. "Niko." [*A. G.*]

CISTICOLA RUFICEPS, *Gould*; *Salvad. t. c.* ii. p. 423. No. 121. Morocco district. "Tuaita." Ground-bird. [*A. G.*]

MUNIA GRANDIS, *Sharpe, anteà*, p. 319. No. 105. Taburi district. "Quaita." [*A. G.*]

General colour above light bay, the rump and upper tail-coverts shining straw-yellow; least and median wing-coverts like the back; greater coverts darker and more chestnut; primary-coverts and quills dusky brown, externally chestnut, the innermost secondaries entirely of the latter colour; centre tail-feathers straw-yellow, dark brown along the middle; remainder of tail-feathers dark brown, edged with straw-yellow; entire head and neck all round jet-black, as well as the breast and entire under surface, with the exception of a patch of light chestnut on the sides of the breast and upper flanks; under wing-coverts and axillaries light reddish, the lower series ashy rufous; quills dusky brown below, ashy rufous along the edge of the inner web. Total length 4 inches, culmen 0·5, wing 2·2, tail 1·55, tarsus 0·65.

DONACICOLA NIGRICEPS, *Ramsay*; *Salvad. t. c.* ii. p. 441. No. 113. Choqeri district. "Tudita." Eyes very dark; legs dark slate-colour. [*A. G.*] A very distinct species, of which Mr. Goldie sends a large series.

MINO DUMONTI, *Less.*; *Salvad. t. c.* ii. p. 466. East Cape (*Hunstein*).

MANUCODIA COMRII, *Sclater*; *Salvad. t. c.* ii. p. 497. "Shot on Normanby Island; not seen elsewhere. Kind of Crow, with a windpipe commencing at the beak and extending down the throat to the abdomen, and back to the throat. Their note is a whistle—*r-r-r-r-r*. Iris red; feet black." (*Hunstein.*)

MANUCODIA CHALYBEATA (*Penn.*); *Salvad. t. c.* ii. p. 498. No. 79. Taburi district. "Manadubu." [*A. G.*]

PHONYGAMA KERAUDRENI, *Less.*; *Sharpe, Cat. B.* iii. p. 180.—P. Jamesii, *Sharpe, t. c.* p. 181.—Manucodia Keraudrenii, *Salvad. t. c.* ii. p. 510. East Cape (*Hunstein*). As already mentioned, I am content to believe *P. Jamesii* to be the same as *P. Keraudreni.*

PHONYGAMA HUNSTEINI, sp. n.—*P.* similis *P. Keraudreni*, Less., sed purpurea, nec chalybeo-nitens, capite undique oleaceo-

viridi. Long. tot. 13·5, culmen 1·45, alæ 7·1, caudæ 6·8, tarsi 1·55. East Cape.

This seems to me to be quite distinct from *P. Gouldi* and *P. Keraudreni*, being nearly an inch longer in the wing and tail, while the bill is also longer and stouter. When Count Salvadori visited England, he brought with him a series of *Phonygamæ* to convince me that my *P. Jamesii* was nothing but the old *P. Keraudreni* of North-western New Guinea; and on seeing his series, I was obliged to admit the truth of his surmise. I do not, however, anticipate a like suppression for *P. Hunsteini*, which seems to be quite different. It may be briefly described as larger than either of the above-mentioned birds, and *entirely purple*, but with an *oily green* head like *P. Gouldi*. There is not a vestige of steel-blue about the whole bird. Unfortunately the number attached to the specimen has come off during the voyage; and the result is that I cannot with certainty identify the specimen in Mr. Hunstein's list. It may possibly come from Normanby Island instead of the mainland.

PARADISEA RAGGIANA, *Sclater*; *Salvad. t. c.* ii. p. 613. No. 1. Choqeri district. "Fanava."

"Plumed bird found usually in high country on mountain-ranges, but young males and females seen in flocks on low but thick scrubby country. The plumed birds usually congregate in the morning and towards sunset on trees, called by the natives 'Marrara' (dancing) trees, sometimes in considerable numbers. The natives in this district catch them with a long string, having a peculiar loop, placed on one of the branches of the tree frequented by the birds; when pulled smartly, this catches the bird by the leg. This is how plumes are obtained from the coast natives, who trade with them with the inland tribes." [*A. G.*]

East Cape and on a river in Milne Bay. "Iris yellow; feet chocolate colour. They call the same as elsewhere, a prolonged *whok—whok—whok*." (*Hunstein.*)

DIPHYLLODES CHRYSOPTERA, *Gould*; *Salvad. t. c.* ii. p. 641. No. 2. Choqeri district. "Thego."

"This bird is found in very rough and thick scrubby country at the head of gullies or on steep sidings, where he clears a space of ground, about 7 feet by 4, by stripping all the leaves and twigs off the bushes, leaving only the heavier branches. The ground is cleared of all leaves &c., and is quite bare, and this seems to

be his playground; in it he dances and flutters about, as if at play. The natives know his call and attract him; but as soon as he perceives any one, away he flies, and can be tempted no more at that time. When not about the nest, he is to be found in exceedingly high trees. His food consists of seeds. Eyes dark; legs blue." [*A. G.*]

No one can doubt that this *Diphyllodes* is a true Bird of Paradise; and the above interesting note by Mr. Goldie goes far to prove the correctness of Mr. Elliot's view that the Bower-birds are also connected with the Paradisiidæ. I have recently taken a different view in my 'Catalogue of Birds;' but I must say that my opinion is very much shaken, and if I were to rewrite the latter work, I would follow Mr. Elliot and Count Salvadori in associating the Bower-birds and the Birds of Paradise.

The British Museum secured from a former collection of Mr. Goldie's a pair of adult birds and a young male of the present species, and I carefully compared them with Mr. Gould's types, which are also now in the National collection. They are perfectly identical, and we have now obtained from Mr. Goldie the exact habitat of the species. It becomes therefore doubtful if the specimens from Jobi, mentioned by Count Salvadori (*l. c.*), which, according to that author, present certain differences from the figures of Gould and Elliot, are really the same species, and an exact comparison would be interesting.

Cicinnurus regius (*L.*); *Salvad. t. c.* ii. p. 646. No. 4. Taburi district. "Atea." Seems to prefer flat country, where he may be found in trees thickly covered with berries, and, like the two former birds, seems to stay in the same locality. [*A. G.*] East Cape (*Hunstein*).

Ptilorhis intercedens, sp. n.—♀ similis ♀ *P. magnificæ*, et eodem modo colorata; supra pallide castanea, pileo concolori, sed quam is *P. magnificæ* clarius rufo, regione parotica et striga malari sordide castaneis nec nigricantibus; subtus multo pallidior, haud ita crebre nigro transfasciata. Long. tot. 12, culm. 2·1, alæ 6·9, caudæ 4·3. ♂ similis ♂ *P. Alberti*, sed rostro breviore et crassiore et pectore imo et abdomine toto purpurascente. Long. tot. 12, culm. 2·1, alæ 7·25, caudæ 4·1, tarsi 1·7.

Hab. East Cape and Milne Bay [*A. G.*].

"Black Bird of Paradise, very similar to the Australian Riflebird, but has a different call. It calls on two notes, one deeper than the other, similar to that of the Raven. Eyes and feet

black. The bird is shy and difficult to get at; it resorts mostly to the ranges, and frequents trees with plenty of vines and creepers on them." [*C. Hunstein.*]

I have already remarked on the differences exhibited by the female Rifle-birds from South-eastern New Guinea; and now that I perceive them to be constant, I have no hesitation in regarding the Rifle-bird of this locality as a distinct species. It must be remembered that in the genus *Ptilorhis* the females are always very different, while the males are very closely allied. The male of *P. intercedens* is certainly very like the same sex of *P. Alberti*, but has a shorter and a stronger bill; and, moreover, the general aspect of the bird below is more entirely reddish purple, the oily brown colour of the breast being confined entirely to that part, while in *P. Alberti* the oily brown colour extends over the greater part of the breast, and only the lower abdomen is reddish purple.

DREPANORNIS ALBERTISII, *Sclater*; *Salvad. t. c.* ii. p. 549. No. 5. Taburi district. "Waeta."

The four specimens sent by Mr. Goldie are all females or immature males. The tail is much paler than in Arfak examples; but until the male is discovered it would be premature to suggest that the bird from South-eastern New Guinea is distinct.

Mr. Goldie writes:—"The plumed bird (male) we have been unable to obtain, although we have shot the young male and female two seasons in different localities, and the natives recognize and name them on seeing a coloured plate; but we have never had the good fortune even to see one."

ÆLURŒDUS STONEI, *Sharpe*; *Salvad. t. c.* ii. p. 678. No. 94. Choqeri district. "Yavitagga." [*A. G.*] Mr. Goldie sends two eggs, said to be of this Cat-bird, which are white, very different from the only Bower-bird's eggs yet discovered.

PTILOPUS BELLUS, *Sclater*; *Salvad. Ann. Mus. Civic. Genov.* ix. p. 197. No. 23. Choqeri district. "Bebero." [*A. G.*]

PTILOPUS GESTROI, *Salvad. & D'Alb.*; *Salvad. Ann. Mus. Civic. Genov.* ix p. 197. No. 24. Choqeri district. "Mabu." [*A. G.*]

PTILOPUS PULCHELLUS, *Gray*; *Salvad. Ann. Mus. Civic. Genov.* ix. p. 198. No. 21. Taburi district. "Toie."

PTILOPUS SUPERBUS (*Temm.*); *Salvad. Ann. M. C. Genov.* ix. p. 199. No. 15. Taburi district. "Arokire." [*A. G.*] Mainland of China Straits. Iris red; feet a dark reddish colour (*Hunstein*).

MEGALOPREPRIA POLIURA, *Salvad. Ann. Mus. Civic. Genov.* xii. p. 426. No. 19. Choqeri district. "Evveacale."

CARPOPHAGA ZOEÆ, *Less.*; *Salvad. Ann. Mus. Civic. Genov.* ix. p. 201. No. 17. Choqeri district. "Eritotta." [*A. G.*]

CARPOPHAGA PINON (*Quoy et Gaim.*); *Salvad. Ann. Mus. Civic. Genov.* ix. p. 202. No. 8. Taburi district. "Bia." [*A. G.*]

CARPOPHAGA MUELLERI (*Temm.*); *Salvad. Ann. Mus. Civic. Genov.* ix. p. 202. No. 12. Taburi district. "Animyta." [*A. G.*]

GYMNOPHAPS ALBERTISII, *Salvad. Ann. Mus. Civic. Genov.* vi. p. 86. No. 10. Taburi district. "Haw-haw." Eyes slate; legs reddish; skin around eye bright red. [*A. G.*]

IANTHŒNAS ALBIGULARIS, *Bp.*; *Salvad. Ann. Mus. Civic. Genov.* ix. p. 203. No. 25. Choqeri district. "Watacune." [*A. G.*] I now believe my *I. Rawlinsoni* to be nothing but the above species.

REINWARDTŒNA REINWARDTI (*Temm.*); *Salvad. Ann. Mus. Civic. Genov.* ix. p. 203. No. 11. Taburi district. "Secuo." Fruit-Pigeon. [*A. G.*] Milne Bay. Iris white; base of bill and eyelids turkey-red; feet red (*Hunstein*).

MACROPYGIA DOREYA, *Bp.*; *Salvad. Ann. Mus. Civic. Genov.* ix. p. 204. Nos. 13, 14. Taburi district. "Cua." "The two birds numbered 13 and 14 are the same bird, but different numbers have been put on by mistake. The Dove with the light-coloured top to the head is the male." [*A. G.*]

PHLOGŒNAS RUFIGULA (*Jacq. et Pucher.*); *Salvad. Ann. M. C. Genov.* ix. p. 205. No. 28. Choqeri district. "Uguto." Ground-bird; makes a noise like the rolling of a drum. [*A. G.*]

PHLOGŒNAS JOBIENSIS (*Meyer*).—Chalcophaps jobiensis, *Salvad. Ann. Mus. Civic. Genov.* ix. p. 207. No. 20. Choqeri district. "Rabugodi." [*A. G.*]

HENICOPHAPS ALBIFRONS, *Gray*; *Salvad. Ann. Mus. Civic. Genov.* ix. p. 207. No. 9. Taburi district. "Rabugodi." "A Ground-Pigeon, which, when disturbed, flies into a low tree, and is easily shot; but they are very rarely seen. I found an egg in one of the birds. Eyes dark; legs black." [*A. G.*] Mainland of China Straits. Eyes black; feet red (*Hunstein*).

CALŒNAS NICOBARICA (*L.*); *Salvad. Ann. Mus. Civic. Genov.* ix. p. 208. Shot on an island in Milne Bay. Iris dark brown; feet a lightish brown (*Hunstein*).

OTIDIPHAPS CERVICALIS, *Ramsay*, *Proc. Linn. Soc. N. S. W.* vol. iv. p. 470. No. 7. Taburi district. "Keo." Eyes red. "This ground-bird is only found inland, in high country. It has a long plaintive note in calling, which, when imitated, brings him towards one. He then stalks to and fro, with tail erect and spread, challenging the intruder. When disturbed he will fly into low trees and bushes, but is quickly away again. The nest is composed of a few twigs, scraped together at the foot of a large tree in a sequestered place." [*A. G.*]

The eggs sent by Mr. Goldie, two in number, were, as might have been expected, pure white.

TALEGALLUS PYRRHOPYGIUS, *Schlegel.*—Talegallus (Æpypodius) pyrrhopygius, *Oustalet*, *Ann. Sci. Nat. Zool.* 1881, p. 41. No. 174. Choqeri district. "I-hu-hu." "Eyes dark brown; legs yellow, but dark brown in front; bare skin about the head livid, like Common Turkey. When obtained, the skin was light, with yellow, pinkish, and blue colours (faint) about it. These birds were obtained in exceedingly rough country, and flew into a low tree when disturbed. The nest is, like that of the Common Turkey, composed of leaves, but smaller, being only about 6 feet in diameter and 3 feet in height." [*A. G.*]

MEGAPODIUS DUPERREYI, *Less.*; *Oustalet*, *Ann. Sci. Nat. Zool.* 1881, p. 77. No. 84. Choqeri district. "Rabugodi."

TIGRISOMA HELIOSYLOS (*Less.*); *Salvad. Ann. Mus. Civic. Genov.* xiv. p. 133. No. 98. Choqeri district. "Essagi." Legs yellow. [*A. G.*]

On the Genus *Pleurechinus*, L. Agassiz: its Classificatory Position and Alliances. By Professor P. MARTIN DUNCAN, M.B. (Lond.), F.R.S., F.G.S., &c.

[Read June 15, 1882.]

PLEURECHINUS, a genus of the Temnopleuridæ, was established by L. Agassiz, in his monograph on the 'Echinodermes Scutelles,' in 1841. It included the species *Pleurechinus bothryoides*, Agass. (1841); and the following is the diagnosis of the genus given in the 'Revision of the Echini' (p. 464) by Alexander Agassiz:—

"Echini resembling *Temnopleurus*, but having a more ovoid outline, with simple pores arranged in straight or undulating lines. Actinostome small, scarcely cut. Tubercles imperforate,

indistinctly crenulated. The sutural impressions in the shape of deep disconnected pits, occurring not only in the angles of the plates, but sometimes three or four, even six, in a horizontal suture."

The species *Pleurechinus bothryoides*, L. Agassiz, was founded on a solitary specimen, which has a denuded test. A. Agassiz states, in the 'Revision,' p. 465:—"It is unfortunately in such a condition that no specific description of any value can be made, and I can do nothing except to call attention to the species, totally unlike, as far as it goes, any other species of Temnopleuridæ known to me." There are four deep disconnected pits of about equal size along the sutures of the plates above the ambitus, and there are two pits in the ambulacral area. The poriferous zone is narrow and undulating. In the interradial areas, the primary tubercles form three vertical rows and are of uniform size; there are two outer rows of smaller tubercles separating the pits from the poriferous zone. The pits in the interradial areas are separated by the primary tubercles. In the ambulacra there are two principal outer vertical rows of primary tubercles, and two irregular median vertical rows of smaller tubercles. The test of the species is quite high, ovoid, with an outline recalling somewhat *Amblypneustes*.

Other forms were confounded with this species; but it is quite clear that no more than four pits occur in horizontal series in the interradials, and two in the ambulacra. The condition of the specimen probably prevented a distinct statement regarding the crenulation of the tubercles. The specimen was wrongly stated to have been derived from the Galapagos Islands; but Alex. Agassiz very properly remarks that it must have come from the East-Indian archipelago or the Philippines.

Alex. Agassiz states * that "this genus corresponds to the genus *Opechinus*, Desor, which was established to receive several very characteristic fossil species of Temnopleuridæ, which D'Archiac and Haime distributed in *Temnechinus* and in *Temnopleurus*." In order to clear the way for placing the genus *Pleurechinus* in its proper position, and to give it a proper classificatory value, it is necessary to consider this statement first of all.

Opechinus, Desor (1858), includes the above-mentioned Echini described by D'Archiac and Haime, and a small specimen forming

* 'Revision of the Echini,' p. 465.

the species *Opechinus percultus*, Desor, from the tertiaries of Java.

With regard to the Echini described by D'Archiac and Haime in 'Les Animaux fossiles de l'Inde,' the types of which are in the collection of the Geological Society, the condition of preservation is wretched; and those distinguished naturalists, in order to convey their meaning to their artist, inked the surface of the tests. Hence every depression along the sutural lines seems to be of great importance. Specimens of so-called Temnopleuridæ from the same geological horizon, now in course of description and publication by Percy Sladen, F.G.S., and myself, indicate the meaning of the multiplicity of depressions on the test. They are the normal depressions (the so-called pits, but not true pits) along the horizontal sutural lines of the test, and nothing more; but the ornamentation of the raised rib-like structure of the test, which carries the principal tubercles and several rows of minute ones, sometimes extends over the depression, and nearly or quite unites with the corresponding ornamentation of the neighbouring rib. When a specimen is slightly worn and inked, the impression conveyed to the eye is that there were two or more smaller depressions within the line of the normal large one.

There are always four depressions along a horizontal line above the ambitus in *Temnopleurus*, and normally there should be only two; but the two vertical rows of large primaries have their base continued over the horizontal sutural depression, and four depressions are formed.

The genus *Opechinus* is valueless, as its essential character, never generic, is due to the chances of growth of ornamentation.

It is remarkable that Desor should write about the species of *Opechinus*, that there were living and fossil species, the first inhabiting the tropical seas. Certainly no form like an *Opechinus* has ever been seen in a perfect and good state of preservation. It must be noticed also, that the type of L. Agassiz does not warrant the statement that there are six pits in horizontal series.

The next notice of the genus *Pleurechinus* is found in A. Agassiz's magnificent Report on the Echini of the 'Challenger' Expedition (p. 108, pl. x^a. figs. 1, 2). Specimens of the species *bothryoides* were obtained off Kobi, in Japan, in from 8 to 20 fathoms.

The following is the description:—"The 'Challenger' collected three small specimens of a Temnopleurid, which I am

inclined to refer to the subgenus *Pleurechinus*, Agass.; they are unfortunately not large enough to compare directly with the typical *Pleurechinus bothryoides*. They show clearly, however, that we may expect to find in the China Seas a species of *Temnopleurus* still retaining the principal features so characteristic of some of the Nummulitic species of India figured by D'Archiac and Haime (see pl. xiii. fig. 7, of *Temnopleurus Valenciennesi* of their work), to which the specimens of the 'Challenger' are most closely allied.

"The outline of the test even in these young specimens (measuring, the largest not more than 18 mm. in diameter) is high, resembling already somewhat the globular shape of such species of *Amblypneustes* as *A. griseus*, and differing from the other species of Temnopleuridæ, in which the outline of the test is quite conical at a corresponding age. The genital ring is narrow, compact, slightly pentagonal; the genital plates are of uniform size, with the exception of the madreporic genital, which is somewhat larger and rectangular in outline, the pores covering its entire surface with the exception of the space occupied by the ring of secondary tubercles, which runs along the inner edge of the genital plates, separating them from the anal system. In addition to this edging, the genital plates carry from two to three tubercles, irregularly placed on the plates, and a few miliaries. The genital openings are deep, crescent-shaped notches, cut out of the outer edge of the plates; the genital plates are united along the anal edge, and a distinct pit in the angle of the sutures between the genital and ocular plates separates the latter from the edge of the anal system. The anal system is covered by an outer row of large triangular plates, with smaller elongate plates arranged round the anal opening.

"In the interambulacral area there are two disconnected pits at the two extremities of the horizontal sutures separating the coronal plates. The coronal plates carry from one to three large primary tubercles, arranged in a horizontal row near the lower edge of the plate, with a somewhat undulating horizontal line of smaller secondary tubercles above that, the rest of the plate being filled with granules, miliaries, and secondaries irregularly arranged. In the ambulacral area the pits are only slightly smaller, but there is only a single large pit at the median end of the suture; the pit at the other extremity of the suture is reduced to a minute impression at the angle of the coronal plate adjoining the pori-

ferous zone. There is a distinct vertical row of primary tubercles on the outer edge of the coronal plates, extending along the whole length of the poriferous zone ; the rest of the ambulacral plate is occupied by an inner and somewhat smaller tubercle, and an irregular horizontal line of secondaries with miliaries extending above the larger tubercle. The pores form very indistinct, irregular, vertical arcs of three pairs ; the pores are separated by slight ridges, and the miliaries of the coronal plates sometimes encroach on the outer edge of the poriferous zone."

The delineations of the apical system, and of some interradial and ambulacral plates above the ambitus, are beautiful examples of correct art (Report on Echini, 'Challenger' Expedition, pl. x^a. figs. 1, 2).

It will be noticed that in this description of the species and its delineation there are no structures brought forward, or drawn, which would ally the form with the *Opechini*. The generic diagnosis requires, therefore, the abolition of the character of possessing more than the normal number of horizontal sutural depressions. Nothing is said, moreover, about the crenulation of the primary tubercles, and the drawing shows them to be non-crenulate.

The carefully-described and well-drawn apical system, with its circle of tubercles around the anus, and the depressions between the ocular plates and this row of tubercles, are new features. It is a truly Temnopleurid apical system ; and the truth of this statement may be gleaned by examining young and old specimens of *Temnopleurus toreumaticus*, and then referring to the apices of the other recent species. A series of specimens of different dimensions of *Temnopleurus toreumaticus*, from the coast of Cutch, has been examined ; and I find considerable variation in the ornamentation of the anal ring. But the depressions between the ocular plates and the circle of tubercles, or, rather, between the ocular plates and the junction of the generative plates, are perfectly distinct in some, but not in other specimens. The only distinction that can be drawn between the two forms is, that there are more tubercles around the anus (and a tubercular ornamentation on the generative plates) in *Pleurechinus bothryoides* than in the common *Temnopleurus*. However, there is a tuberculate ornamentation in the other species of *Temnopleurus* on the plates. The apical system of *Pleurechinus* will not, then, separate it from *Temnopleurus*.

The nature of the poriferous zone does not separate the genera. It is evident that every specimen of *Temnopleurus* presents crenulation of its primary tubercles, although it is often indistinct in some parts of the test. The tubercles of *Pleurechinus*, when carefully examined, do not show crenulation any more than specimens of *Temnechinus*, Forbes. What is seen in improperly denuded tests are the relics of the soft tissue which extended over the boss to the ring of the spine.

The examination of the construction of the test of *Pleurechinus bothryoides* should prove the classificatory position of the form in relation to the genera *Temnopleurus* and *Temnechinus*; and this proceeding was possible from the kindness of Dr. Günther, F.R.S., of the British Museum. Several specimens of *Pleurechinus bothryoides* are in the National collection. One, a denuded test, has been in the collection for years, and doubtless is a fellow of the type in Paris; others were dredged by the 'Alert' in the Japanese seas, and there are the specimens collected by H.M.S. 'Challenger.' Dr. Günther gave me his sanction to utilize one of the specimens, and I chose one of the forms from the 'Alert' collection. The first examination of the outside of the test enabled me to admire A. Agassiz's description and drawings of the species; the second proved that the smallest and almost miliary tubercles near the sutural depressions carried long stalked pedicellariæ resembling those of *Temnopleurus*, and that there were globose, slightly elongated sphæridia on short stalks at the edge of the actinal sutural depressions close to the peristome.

The third examination consisted in carefully breaking asunder the coronal plates and separating them from the poriferous zones of the ambulacra. This was done with the view of determining whether the test had true pits passing inwards and undermining the test at the sutural angles, besides the sutural depressions, which are such marked features and are usually called pits; also to make out whether or not there was any knob-and-socket suturing along the median line of the plates, and also on the horizontal edges actinally and abactinally. In fact, I was desirous to discover whether the form had any structural relations with *Temnopleurus*, *Salmacis*, and *Amblypneustes* *.

All the structural characters of the sutures of *Temnopleurus* were found in *Pleurechinus bothryoides*, more or less modified.

The depressions along the lines of horizontal sutures, called by

* Journal of the Linnean Society (Zoology), vol. xvi. 1882, p. 343, pl. viii.

Agassiz pits, are deep, and are increased by the elevated ridge-like ornamentation which carries the tubercles ; they are marked on their floor by the margin of the suture, or where two contiguous plates join; and they dip inwards at the sutural angle, penetrating and expanding slightly, and leaving but a thin layer of reticulate test between them and the interior of the test. On the edge of the plate, on either side of the true pits, are processes with knobs and sockets, and these are larger and fewer in number than in *Temnopleurus toreumaticus*. Between the interradial coronal plates and the tentaculiferous plates there is the same kind of suturing as in *Temnopleurus*. Knobs on the ambulacral edges, and sockets on the interradials, with considerable undermining of the true pits here and there. The knobs are larger, however, than in *Temnopleurus*. The horizontal sutures, actinal and abactinal, show the knob-and-socket arrangement very feebly; the knobs and sockets are few in number, and are not seen all along the adjoining plate-edges beneath the depressions, but only on the sutures where the raised ornamental ridges join. There a few sockets fit corresponding knobs on the other plate; the distribution, however, of the knobs and sockets is as it is in *Temnopleurus*, and there is the same difference in the relative position of the knobs and sockets in the interradial and ambulacral areas.

Finally, not only pedicellariæ with stout heads on long stalks are close to the depressions over the horizontal sutures, but there are rather long-headed pedicellariæ on short stalks immediately around the edge. There is often a definite indication that not only are these depressions and true pits lined with membrane which does not carry pedicellariæ or any structures, but that a layer of tissue covers in, more or less, the depressions, not at the level of their edge, but a little lower. It appears to be incomplete, and to have a slit-like opening in it, so that the deeper part of the depression and the true pit are more or less covered in. Neither ova nor young are found in these depressions, although their marsupial character is very present to the imagination.

In minute construction, there is a generic relation between *Temnopleurus* and *Pleurechinus*, and the only important distinction is the absence of crenulation in the last-named type. The value of this distinction is not great; but when certain series of forms have crenulate tubercles without exception, and one occurs, closely allied by its minute structures, having non-

crenulate tubercles, the distinction is of some classificatory importance.

The classificatory position assigned by A. Agassiz to *Pleurechinus* in the 'Revision' must be conceded, and it is a subgenus or section of *Temnopleurus*.

It might be contended that *Pleurechinus*, having non-crenulate tubercules, is identical with *Temnechinus*, Forbes; and A. Agassiz evidently considers it closely allied to the Nummulitic members of the Temnopleurid group described by D'Archiac and Haime.

But *Temnechinus*, Forbes, has no true pits at the sutural angles, and the depressions over the sutural margins do not therefore terminate in deep inward undermining or penetrations of the test.

A careful examination of the tests of the Crag *Temnechini* in the British Museum, the Royal School of Mines, and in the collection of the Geological Society, indicates that none of the remarkable minute structures of the test of *Temnopleurus* are present.

Forbes's determination of the lack of pits at the angles, depressions only existing, and of the absence of crenulation in *Temnechinus* holds good; and no forms can enter the genus which have true pits and crenulated tubercles.

Pleurechinus is therefore not synonymous with *Temnechinus*, and, as may be gleaned from my communication on the Temnopleuridæ to this Society (Proc. Linn. Soc., Zool. 1882, vol. xvi. p. 343), they belong to different genera.

The Temnopleuridæ from Sind, referred to by A. Agassiz, have no true pits; but the tubercles are crenulate. Their state of preservation and the absence of the apical system prevent their being satisfactorily classified. But amongst the Temnopleuridæ lately received from Sind there are forms with a remarkable apical system, and a condition of the outside of the test which brings them under distinct genera. It is probable that the forms described by D'Archiac and Haime will come under one of these generic divisions, so that the whole series will be in alliance with *Glyphocyphus* (Haime) and *Trigonocidaris* (Agass.).

Notes on some Habits of the Scorpions *Androctonus funestus*, Ehr., and *Euscorpius italicus*, Roes. By E. Ray Lankester, M.A., F.R.S., Jodrell Professor of Zoology in University College, London.

[Read June 15, 1882.]

I. Observations on Androctonus funestus.

Early in last November I received from Biskra, in the south of Algeria, through the kindness of Professor Carl Vogt, six living specimens of the beautiful citron-coloured Scorpion, *Androctonus funestus*. A cage, measuring 3 ft. by 4 ft., and covered above by glass, was prepared for them. The cage was kept at a temperature of 65° Fahr. by means of gas, and some six inches in depth of fine sand and gravel was placed on the floor of the cage.

The Scorpions were all active enough after their journey, which they had made whilst packed in sand. All were full-grown, measuring three inches and a half from the front margin of the cephalic shield to the anus, excepting one which was about half this size. This small specimen was found torn into two pieces, and the soft tissues sucked out of the integument, on the day after the arrival of the specimens. The other five lived about four months: one died without apparent cause; a second was killed, and its soft tissues consumed by its companion; whilst the other three were killed for dissection and experiment.

Burrowing in Sand.—A pan of water was placed in the cage with the Scorpions, but the Scorpions were never seen to visit it. They preferred the drier parts of the sand, in which they buried themselves, excavating each a tunnel for its own habitation. These tunnels were often as much as eight inches in length, and ran horizontally just below the surface of the sand. In consequence of the sand having become caked by the sprinkling of water on its surface, the Scorpions were able to work upon it in the way mentioned.

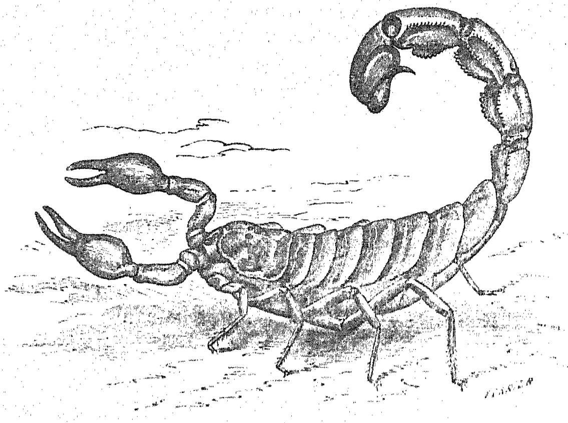
The process of excavation was observed on several occasions. The Scorpion commenced by pushing the large chelæ into the sand, and scraping backwards with the three anterior pairs of walking-legs; whilst the hindmost pair of walking-legs did not share in this movement, but remained motionless, acting as a

support for the body. The scraping action was very rapid, the sand being thrown out by the quick strokes of the three pairs of legs in a constant shower, and to a distance of three or four inches, so as to produce a curious rattling sound.

The use of the legs in burrowing in this species of Scorpion is interesting to compare with the parallel but not identical use of the legs in *Limulus*. *Androctonus funestus* is, it should be observed, distinctly an inhabitant of sandy regions, to which fact its pale yellow colour is related.

General Carriage in Locomotion and Mode of using the Sting.—These Scorpions were by no means courageous, but, on the contrary, very timid. During the daytime they were always hidden in their burrows, or under the water-pan, or pieces of wood. If brought to the surface, they gave very little evidence of sight, and none of hearing, and endeavoured as rapidly as possible to hide themselves again. The carriage is remarkable, differing much from that of *Euscorpius carpathicus* and *E. italicus*. The

Fig. 1.



Androctonus funestus, var. *citrinus*, Ehr.
Drawn from the living animal, March 1882.

body is well raised from the ground, the tail reflected over the back, and the sting carried just over the back of the cephalic shield, ready to give a forward stroke, whilst the large chelæ are widely outstretched and held horizontally, acting most obviously as tactile organs, the creature feeling its way with them. The

movement is very steady, giving the impression of something on wheels, and is never rapid—never so rapid as to escape a man's complete control. They could be handled with impunity if *rapidly* seized by the last joint of the tail; but if *slowly* approached, a vigorous stroke was delivered at the approaching object by the tail, directed so as to give the sting effect. Complete directive power exists in regard to these movements of the tail. The blow can be delivered either straight forwards over the head, straight backwards, or to the right or to the left. In this particular species the tail is relatively far larger and more powerful than in any other Scorpion, and its blows (as tested against a piece of wood) are of very great strength.

Capture of Prey.—I had some difficulty in feeding these Scorpions. They appeared not to care for such small game as blowflies. Some newly-born white mice were appreciated by two out of the five; and they all took, at different times, the large ship's cockroaches which were placed in quantity in the cage with them, though they would not touch the common blackbeetle. They never fed excepting at dusk or in the night; so that it was difficult to observe their proceedings. But on two occasions I saw cockroaches attacked. Probably the Scorpion never *pursues* its prey, but comes upon it by stealth. The cockroaches walked unsuspectingly up to the Scorpion when I was observing the cage with a light just after dark, and suddenly one was seized by the large left chela of the Scorpion; at the same moment the sting was swiftly brought over the Scorpion's head, and *two* stabs in quick succession were administered to the cockroach *. The Scorpion then carried off its prey, *holding it in the large chela*. Having found a quiet place in which to feed, the Scorpion tore off the head of the cockroach by means of its chelæ, and *then inserted the chelicerœ* into the soft substance of its prey. The struggles of the cockroach had lasted about two minutes; and not until they had ceased did the Scorpion release the hold of it by his large chela and commence the feeding operation. When *now* disturbed the Scorpion did not carry his food by means of one of the large chelæ as before, when that food was still alive and struggling. *Now* he carried the dead cock-

* The poison-gland of the Scorpion is double: each gland is invested by a powerful muscle, the contraction of which expels the poisonous secretion. I have studied the structure of the Scorpion's sting and poison-gland by means of sections prepared for me by my assistant, Mr. A. G. Bourne, B.Sc.

roach held firmly by the cheliceræ, and thus left his chelæ free for attack or defence. I observed this on other occasions: a Scorpion, when disturbed feeding, always carries off its prey held in the cheliceræ, leaving the chelæ free for other uses.

Mode of ingestion of Food.—The exact mode of bringing the food into the mouth is, naturally enough, very difficult to observe. The mouth of the largest Scorpions existing is a minute aperture not so broad as the shank of an ordinary pin; and food is drawn into this aperture by a remarkable pumping action of the pharynx, the mechanism of which has been described by Professor Huxley *. The cheliceræ, though short, are in all Scorpions provided with exceedingly powerful muscles, and the surfaces corresponding to the cutting-edges of a pair of nippers are not simply cutting-surfaces, but are broad, and fitted rather for crushing than cutting. On one occasion I was able to observe the cheliceræ at work, when the Scorpion was feeding upon a young mouse. Each chelicera was protruded, and then withdrawn alternately with its fellow, first the right and then the left, the retraction tending to bring down towards the mouth the soft tissues of the mouse. The range of protrusion and retraction of the chelicera is about equal to its total length. During this process the cheliceræ were grasping the intestine and mesentery of the mouse, and the alternate movement of the right and left sides suggested the action of "milking."

Although these Scorpions always left large portions of the hard substances of their prey unconsumed, and though, from the structure of the mouth, it is clear that no large particles of hard substance can be taken into the alimentary canal, yet it is a fact that a considerable portion of the chitinous cephalic shield, and dorsal sclerites also, of the Scorpion which fell a victim to one of its fellows was destroyed, and apparently had been consumed by the cannibal. The edge of the remnant of the cephalic shield was notched, as would have been the case had it been crushed by the cheliceræ of the attacking Scorpion; and I am led to the conclusion that, by the aid of the short crushing nippers constituted by the cheliceræ, the larger Scorpions may pulverize very dense substances, and subsequently introduce them into the very narrow oral aperture by suction.

Swelling after Food.—The Scorpion which fed upon its companion became as a consequence greatly distended, the soft in-

* Quart. Journ. Micr. Sci. 1860, p. 250.

tegument between the dorsal and ventral sclerites of the mesosoma being stretched until quite tense. It seems to be a legitimate conclusion that the food-matters sucked in by the Scorpions are not retained simply in the narrow median tract of the alimentary canal, but pass into the wide canals of the gastric cæca (so-called liver), where probably they are chemically changed and absorbed.

Excrement.—The contents of the intestine of the Scorpion (*i. e.* the part of the gut which lies in the tail) were always found by me to be white and opaque, consisting of a fine moist powder. Whether this powder was derived from the Malpighian tubes or consisted truly of fæces, I am unable at present to say. No fæces were observed to be deposited by the *Androctonus* whilst in my possession.

The Combs as Sense-organs.—On several occasions I made experiments on the tactile sense of the combs or pectiniform appendages. They appeared to me to possess no special sensitiveness. When they were pinched with forceps, the Scorpion showed no evidence of discomfort. It is quite possible that they may acquire a heightened sensibility at the breeding-season, and serve as guides to the male and female in effecting copulation.

Suicide of Scorpions.—The well-attested statement that a Scorpion when placed within a ring of red-hot embers will, after making futile efforts to pass the fiery circle which surrounds it, deliberately kill itself by inflicting a wound with its sting in its own head, has often been doubted. When killing a Scorpion (*A. funestus*) in a glass box by the use of chloroform vapour, I witnessed something which tends, I think, to throw light on the old tradition, and to confirm its accuracy in the main. As soon as the Scorpion began to feel the effects of the chloroform-vapour, it made repeated blows with its sting in the straight, forward direction above its head. These blows became gradually less definite, and the muscular movements concerned in them less efficiently coordinated. At last one blow was so ill-directed as to cause the tip of the Scorpion's sting to catch under the free projecting margin of the posterior region of the cephalic shield. In this instance the Scorpion did not lacerate itself; but I can well believe that occasionally such a misdirected blow with the sting on the part of a half-suffocated Scorpion has

been seen to cause a penetration and laceration of the cephalic shield, followed by the death of the Scorpion*.

II. Observations on Euscorpius.

For repeated sendings of a large number of Italian Scorpions belonging to the species *E. italicus*, *E. carpathicus*, and *E. flavicaudus*, I am indebted to the great kindness and energy of Mr. Gibson-Carmichael.

Carriage and General Habits.—It is worthy of remark that these small Italian Scorpions (all very closely allied, if, indeed, really distinct, species) are much flatter in the body than *Androctonus funestus*, and that the body is not raised on the legs in walking as in the latter species, but lies close to the ground, the legs being extended on either side. Concurrently with this habit, we find that these Scorpions are more given to pushing themselves under stones and into crevices than is *A. funestus*, and apparently do not make burrows for themselves. The tail is rarely if ever raised over the back as in *Androctonus funestus*; it is dragged behind with the slightest upward curvature only, or a curvature to the right or left. Only under great provocation are blows delivered by the sting if the animal be handled, and these are usually ineffective.

Frequently I have found them under stones in the cage in which I kept them, with the *ventral* surface turned uppermost. In fact this position is more usual than the reverse. I am at a loss to explain the significance of this attitude, unless it be that my specimens were under observation during the spring (March, April, May), and that at this time copulation takes place, when, as has been observed by others, and as is necessary from the position of the copulatory organs, the one sex receives the other in the position described, viz. with the ventral surface turned upwards.

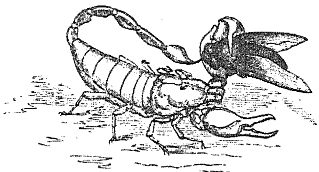
Fighting.—A large number of these Scorpions being placed together in a glass box, some came into conflict one with another. In such conflicts the large chelæ were used, the one seizing with these organs the corresponding organs of the other. But the sting was never brought into use in these contests.

Capture of Prey.—These small Scorpions feed readily on the

* In any attempt to test the accuracy of the statements made as to suicide by Scorpions, it is of great importance to distinguish the species observed. The Spanish Scorpion, concerning which the tradition exists, is an *Androctonus* (*A. occitanus*) allied to *A. funestus*.

bluebottle-fly; they will also take the larvæ and pupæ of the same insect. On several occasions I have witnessed the whole process of capture and killing of such a fly. As with *Andro-*

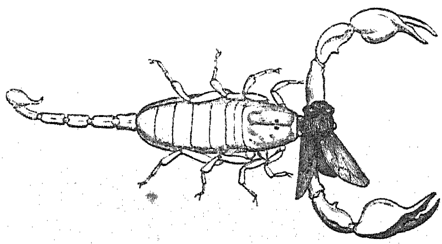
Fig. 2.



Euscorpius piercing fly's head with its sting.

ctonus so with *Euscorpius*, the prey came to the Scorpion by no exercise of agility on the part of the latter, but simply through the carelessness of the fly, who practically walked into the Scorpion's arms. Thereupon the Scorpion firmly grasped the

Fig. 3.



Sketch showing *Euscorpius* using its cheliceræ when sucking the juices of the fly, and the manner in which this genus carries its tail, only slightly bent.

fly with his left large chela, and very deliberately, whilst the fly buzzed and struggled, brought up his sting over his head, and carefully pierced the fly's *head* with his long, fine sting. Having deliberately withdrawn his sting, he again quietly, and with an air of much determination, again introduced the fine sting into the fly's head. The slowness of this stinging process is perhaps to be connected with the fact that the poison-glands have to be compressed by their proper muscles, and the poison squeezed out of the lumen of the gland after the sting has pierced the fly's head.

Having accomplished this operation the Scorpion walked

round with the fly (still struggling), held in his left chela. After three minutes the movements of the fly ceased. Then the Scorpion brought the fly up to its cheliceræ, and released its hold with the left chela. The fly was now carried by the two cheliceræ, the chelæ being left free. I did not observe in these small Scorpions any thing of the method of getting out the juices of their prey.

I am inclined to think that the species of *Euscorpius* do not so readily prey upon their own kind as does *Androctonus funestus*, and as does the Spanish Scorpion allied to *A. funestus*, namely the *A. occitanus*, or yellow Scorpion of Southern France and Spain*. According to Maupertuis, in six weeks one hundred of these *A. occitanus*, kept by him in a cage, were reduced in number to ten, one having eaten another, until at last only these few, presumably the embodiment of the whole hundred, were left.

I trust that these few fragmentary observations may induce others, who have enjoyed greater opportunities, to place on record their experiences as to the habits of various species of these notable and historic Arachnids.

On the Butterflies collected by Lord Walsingham in California.

By ARTHUR G. BUTLER, F.L.S., F.Z.S., Assistant-Keeper, Zoological Department, British Museum.

(Read March 2, 1882.)

THE collection of which the following is an account consists of about eighty species obtained by Lord Walsingham during the years 1871 and 1872 in California, one species only (which I believe to be the *Thecla auretorum* of Boisduval) being taken in Oregon. Compared with other collections from this country, the present is by no means poor in species: the first series forwarded by M. Lorquin to Dr. Boisduval contained 83 species of Butterflies; but some of these may have been received from Mr. Doubleday, since Dr. Boisduval says:—" Toutes les espèces mentionées dans cet opuscule ont été recueillies par M. Lorquin, à l'exception de cinq à six, qui nous ont été données par M.

* Since writing the above, I have found three small *Euscorpii*, killed and their juices sucked, in a box sent to me containing eight live specimens when despatched from Italy.

Doubleday." Of the subsequent collections forwarded by M. Lorquin, it would be impossible to guess the exact number of species; but the list of them, published by Dr. Boisduval in 1868, enumerated 62 species, probably representing those received since 1852. Although the rapid growth of entomological science in America rendered it improbable that the present collection would contain novelties, it is none the less valuable scientifically, since it has rendered necessary the reexamination of many species which in past years had been too hastily identified.

One of the principal difficulties which the Lepidopterist has to deal with in the determination of his specimens arises from the fact that the students of this branch of entomology are not agreed as to what constitutes a species or variety. Thus the genus *Hypolimnas* may be allowed to vary in every possible way, and to have a range extending from Nepal to South Australia; but the genera *Pedaliodes* and *Ithomia* cannot be permitted to vary at all, even in the same locality—nay, in characters which the dividers of species would never dream of regarding as more than chance sports.

It may be urged, and to a certain extent it is true, that some genera are more liable to vary than others, owing to the fact that intermediate gradations between the species have not yet been wholly eliminated; but this is, I believe, the exception, and not the rule; and it is often the case that where nearly allied species are asserted to be conspecific, breeding from the egg proves them to belong to different sections of their genus: as an instance, I may refer to *Vanessa comma* and *V. satyrus*, pronounced by Dr. Staudinger to be both races or varieties of *V. c-album*, but proved by breeding to belong to distinct subgroups of the genus.

The following is a list of Lord Walsingham's captures, some few of which, having passed into the collection of Mr. Godman, that gentleman, with his usual courtesy, has kindly put it in my power to examine with the remainder of the collection: these I have added in their natural position in the paper.

NYMPHALIDÆ.

Danainæ.

1. Danais plexippus.—Papilio plexippus, *Linnæus, Mus. Lud. Ulr.* p. 262 (1764).—Papilio archippus, *Fabricius, Ent. Syst.* iii. 1, p. 49 (1793); *Smith, Abbot, Lepid. Insects Georgia*, i. pl. 6

(1797). Mendocino, Tehama, and Siskiyou Counties; May to September.

It has now been decided (see Biol. Centr.-Amer., Lepid. Rhopal. p. 2) that the *Papilio plexippus* of Linnæus must be the species which has been long known under the name of *Danais archippus* of Fabricius and not the Indian species. Although the authors of the Lepidopterous portion of the 'Biologia' have in this instance departed from their usual plan of adopting the name respecting which there could be no question in preference to that of which there might still be the shadow of a doubt, I quite think they are justified in so doing, by the strong circumstantial evidence in favour of the adoption of the name *D. plexippus* for the New-World insect.

SATYRINÆ.

2. CŒNONYMPHA CALIFORNICA, *Westwood & Hewitson, Gen. Diurn. Lep.* pl. 67. fig. 2 (1851). Sonoma County, May 18th to 23rd; Mendocino County, May 24th to June 14th; Lake County, June 15th to 23rd.

3. SATYRUS ARIANE, *Boisduval, Ann. Soc. Ent. France*, sér. 2, x. p. 307. n. 58 (1852). Shasta County, July 10th to 28th; Siskiyou County, July 29th to September 15th.

Nearly the whole of the Butterflies collected by Lord Walsingham were provisionally named for him by Mr. Elwes: the present species I find labelled as the *S. boopis* of Behr; but of that species its author says that it is "only distinguishable from *Nephele* by the absence of eyes on the underside of the hind wings." An examination of the five examples before me gives the following results:—1 ♂ with 6 distinct ocelli on under surface of secondaries; 1 with 6 less distinct ocelli, the first and third without pupils; 1 with 6 still less distinct ocelli, the first to fourth without pupils; 1 with 6 distinct ocelli, but the four first and the sixth extremely small; and, lastly, 1 ♀ with six punctiform ocelli, the pupils having only a black edge. All these specimens agree perfectly with Boisduval's *S. ariane*, described as having "une rangée irrégulière de six petits yeux noirs, à pupille blanche et à iris fauve, groupés trois par trois, et plus ou moins bien marqués"*.

* Of the female Boisduval says, "les petits yeux du dessous des ailes inférieures beaucoup moins visible que dans les mâles."

There is a specimen in Mr. Godman's collection agreeing with the male first mentioned above in having six distinct ocelli on the under surface of the hind wings.

4. SATYRUS SILVESTRIS, *W. H. Edwards, Proc. Acad. Nat. Sci. Phil.* 1861, p. 162. Colusa and Siskiyou Counties in July.

Three male examples of this species I found labelled with a MS. name proposed some years since by Mr. W. H. Edwards, but subsequently abandoned; he writes that "It refers to a small race and slightly pale form of *S. silvestris*, Edw. The drawing you send me is the form I allude to, but it is hardly different enough from the type of *silvestris* to warrant a name."

5. ŒNEIS IDUNA.—Chionobas iduna, *W. H. Edwards, Butt. N. Am.* ii. *Chion.* pl. 1. figs. 1–4 (1874). One male taken in Mendocino County, California, and a female in Mr. Godman's collection.

NYMPHALINÆ.

6. ARGYNNIS MONTICOLA, *Behr, Proc. Cal. Acad.* 1862, p. 172; *Edwards, Butt. N. Amer.* i. *Arg.* pl. 8 (1868). Mendocino County, May and June.

This agrees with examples identified by Dr. Boisduval as *A. zerene*.

7. ARGYNNIS EGLEIS, *Boisduval, Lép. Cal.* p. 59 (1869). A specimen from Mendocino County.

I have named this insect by comparison with two wings of Boisduval's species forwarded by the author in April 1872. I can detect no difference between this species and *A. Behrensii* as figured by Mr. W. H. Edwards, with which it will probably prove to be synonymous.

Mr. Godman also forwarded the following species, presented to him by Lord Walsingham.

7 *a*. ARGYNNIS ATLANTIS, *Edwards, Butt. N. Am.* i. pl. 5. figs. 1–3. California.

7 *b*. ARGYNNIS EURYNOME ?, *Edwards, Butt. N. Am.* ii. pl. 1. figs. 1–4 (1875). California.

The example received from Mr. Godman only differs from the figures by Mr. Edwards in the greater width of the submarginal spots: it is also slightly larger.

8. ARGYNNIS NEVADENSIS, *Edwards, Trans. Amer. Ent. Soc.* 1870, p. 14; *Butt. N. Amer.* i. *Arg.* pl. 14 (1871). Tehama County, California, in July.

Labelled as "*A. macaria* ?, Edw.," a species unknown to me.

9. BRENTHIS EPITHORE.—Argynnis epithore, *Edwards, Proc. Ent. Soc. Phil.* ii. p. 504 (1864). Mendocino and Lake Counties in June.

10. MELITÆA PALLA, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 305. Mendocino and Lake Counties in June.

11. MELITÆA HOFFMANNI, *Behr, Proc. Cal. Acad. Nat. Sci.* iii. p. 89. n. 4 (1863). Mendocino County, May and June.

12. MELITÆA GABBII, *Behr, Proc. Cal. Acad. Nat. Sci.* iii. p. 89. n. 3 (1863). Mendocino County (one female).

13. MELITÆA STEROPE?, *W. H. Edwards, Trans. Am. Ent. Soc.* iii. p. 190 (1870). Mendocino and Colusa Counties.

I feel doubtful about this identification, for although the upper surface of these Californian examples agrees well with the description of Edwards's Oregon specimens, the under surface differs somewhat: the markings described by Edwards as white are in the Californian examples sulphur-yellow, and those described as orange are brick-red; the large crescents are also not 'marginal,' but submarginal, being followed by an undulated red border and white fringe; the discal and subbasal markings vary considerably.

We have received this species from a French dealer with the MS. name *M. aspasia*, Boisd.; it appears to me to be allied to what I regard as probably *M. Gabbii*.

The North-American species of *Melitæa* are about the most difficult of all the butterflies of that country to recognize from descriptions only, yet hardly any of them have been figured. In the nearly allied genus *Phyciodes*, on the other hand, even the melanistic and other sports produced by rearing under the most abnormal conditions have been largely illustrated.

14. MELITÆA LEANIRA, *Felder, Wien. ent. Mon.* iv. p. 106. n. 64 (1860); *Reise der Nov. Lep.* iii. pl. 50. figs. 13, 14 (1867). Siskiyou County, July to September.

15. MELITÆA HELVIA, *Scudder, Entom. Notes (Proc. Bost. Soc. Nat. Hist.* xii. 1868–69), p. 43. Mendocino County.

Improbable as it seems that this should be identical with the Alaska insect, it fits the description in every thing excepting in being rather more highly coloured, the "blackish fulvous" being replaced by black, and the "fulvous" by red. A somewhat faded example of Lord Walsingham's insect would therefore agree in

all respects with Scudder's description. The single example was labelled as *M. palla*, to which, however, it has no affinity.

16. Melitæa chalcedona, *Doubleday in Gen. Diurn. Lepid.* pl. 23. fig. 1 (1847). Shasta County, California.

Twelve examples of this common but striking species are in the collection.

17. Phyciodes camillus, *W. H. Edwards, Trans. Am. Ent. Soc.* iii. p. 268 (1871). Shasta County.

A single example was obtained; it agrees well with the description of the Colorado insect, and also fairly well with one of the insects figured by Mr. Edwards as a melanistic variety of *P. morpheus* (fig. 4).

18. Phyciodes phaon.—Melitæa phaon, *Edwards, Proc. Ent. Soc. Phil.* ii. p. 505 (1864).

Var. Phyciodes vesta (part.), *Edwards, Butt. N. Am.* ii. *Phyciodes*, pl. —. figs. 20, 21 (1878). Mendocino and Shasta Counties.

Var. P. vesta (typical).—Melitæa vesta, *Edwards, Trans. Am. Ent. Soc.* ii. p. 371 (1870). Mendocino County (one example).

This more nearly approaches figs. 18 & 19 of Edwards's plate.

19. Vanessa gracilis.—Grapta gracilis, *Grote & Robinson, Ann. Lyc. N. York*, viii. p. 432 (1867). Mendocino County.

20. Vanessa satyrus.—Grapta satyrus, *Edwards, Trans. Am. Ent. Soc.* ii. p. 374 (1869); *Butt. N. Amer.* ii. *Gr.* pl. 6. figs. 1–4 (1872). Mendocino County.

21. Vanessa hylas.—Grapta hylas, *Edwards, Trans. Am. Ent. Soc.* iv. p. 68 (1872); *Butt. N. Am.* ii. *Gr.* pl. 2. figs. 1–4 (1875). Mendocino County.

The three preceding species I found associated under the name of "*Grapta silenus*;" to my mind they appear to be perfectly distinct.

22. Vanessa Milberti, *Godart, Enc. Méth.* ix. p. 307. n. 25 (1819); *Boisd. & Leconte, Lép. Am. Sept.* p. 187, pl. 50. figs. 3, 4 (1833). Mendocino and Siskiyou Counties.

23. Vanessa californica, *Boisduval, Ann. Soc. Ent. France*, p. 366 (1852). The locality not stated; probably Mendocino County.

24. Vanessa antiopa.—Papilio antiopa, *Linnæus*, *Fauna Suecica*, p. 277. n. 1056 (1761). Mendocino County.

25. Pyrameis cardui.—Papilio cardui, *Linnæus*, *Fauna Suecica*, p. 276. n. 1054 (1761). No exact locality noted.

26. Pyrameis virginiensis.—Papilio virginiensis, *Drury*, *Ill. Exot. Ent.* i. pl. 5. fig. 1 (1773). No exact locality noted.

27. Junonia cœnia, *Hübner*, *Samml. exot. Schmett.* ii. (1816–24). Sonoma and Mendocino Counties; May and June.

28. Limenitis Lorquini, *Boisduval*, *Ann. Soc. Ent. France*, 1852, p. 301. Sonoma, Mendocino, Shasta, and Siskiyou Counties.

29. Heterochroa californica, *Butler*, *Proc. Zool. Soc.* 1865, p. 485. n. 6. Mendocino and Siskiyou Counties.

It is remarkable that most Lepidopterists will persist in labelling this species as *H. Bredowii* of Hübner: the latter is a perfectly distinct species, far more so, indeed, than many of the forms of *Heterochroa* universally regarded as distinct. It does not occur in N. America, the idea that it did having arisen from an inaccuracy in the identification of *H. californica*, which led Mr. Edwards to figure it under Hübner's name; this, however, was corrected by that author in his letterpress as soon as he had an opportunity of comparing the two species.

ERYCINIDÆ.

Erycininæ.

30. Apodemia mormo.—Lemonias mormo, *Felder*, *Wien. ent. Monatschr.* v. p. 101. n. 61 (1861).—Apodemia mormo, *Felder*, *Reise der Nov. Lep.* ii. p. 299. n. 400, pl. 37. figs. 1–4. Klamath River, California; in June.

LYCÆNIDÆ.

31. Lycæna pardalis, *Behr*, *Proc. Calif. Acad.* iii. p. 279. n. 1 (1867). California.

32. Lycæna acmon, *Westwood & Hewitson*, *Gen. Diurn. Lep.* pl. 76. fig. 2 (1852). Mendocino County.

L. antægon of Boisduval seems to be represented by the larger examples of this species; it is said to be a little larger than *L. ægon*.

33. Lycæna anna, *Edwards, Proc. Acad. Nat. Sci. Phil.* 1861, p. 163. A single female, obtained in Mendocino County.

34. Lycæna pheres, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 297. Siskiyou County (*Mr. Godman's collection*).

35. Chrysophanus xanthoides.—Polyommatus xanthoides, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 292. Sonoma County, in May.

36. Chrysophanus gorgon.—Polyommatus gorgon, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 292. Mendocino County.

37. Chrysophanus helloides.—Polyommatus helloides, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 292. Little Shasta.

38. Strymon sæpium.—Thecla sæpium, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 287. ♂ ♀, Mendocino County.

By an oversight, Mr. Elwes labelled this as *T. acadica*, W. H. Edwards, which is a species nearer to *T. Edwardsii*.

39. Strymon tetra.—Thecla tetra, *W. H. Edwards, Trans. Am. Ent. Soc.* iii. p. 19 (1870). ♂, Siskiyou County.

If I have rightly identified this species, it is somewhat allied to *S. mopsus*.

40. Strymon hyperici.—Thecla hyperici, *Boisduval & Leconte, Lép. Am. Sept.* p. 99, pl. 31. figs. 1–4 (1833). Shasta County.

Although nearly allied to *S. melinus*, I cannot regard this species as identical. We have seven examples of *S. melinus* agreeing exactly with Hübner's figure, whereas the Californian species differs markedly in the almost white colour of the under surface of the wings. Whether this species or *S. melinus* is the *Thecla humuli* of Harris, I do not know; if it be the latter, the name will sink into a synonym.

41. Strymon auretorum?—Thecla auretorum, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 287. Rouge River, Oregon.

42. Strymon californica.—Thecla californica, *W. H. Edwards, Proc. Acad. Nat. Sci. Phil.* xiv. p. 223 (1862). Sonoma and Siskiyou Counties.

43. STRYMON ERYPHON.—Thecla eryphon, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 289. Mendocino County.

44. STRYMON DUMETORUM.—Thecla dumetorum, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 291. Mendocino County.

Mr. Godman adds the two following species—*Thecla adenostomatis*, H. Edw., and *T. Henrici*, Grote, both of which appear to have been taken in Siskiyou County: the specimen of the latter species is unusually tawny in colour.

PAPILIONIDÆ.

45. COLIAS EURYTHEME, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 286. Shasta and Siskiyou Counties.

46. COLIAS KEEWAYDIN, *W. H. Edwards, Butt. N. Amer.* i. *Col.* pl. 4 (1869). Siskiyou County.

Mr. Godman also forwards a pair of *Colias Edwardsii*, Behr, presented to him by Lord Walsingham; they are unusually large and well marked.

47. MEGONOSTOMA EURYDICE.—Colias eurydice, *Desmarest, Bull. Ent. Soc. France*, 1855, p. xxxii. ♂, Pit River.

I am quite willing to adopt the name *M. eurydice* rather than use that of *M. Wosnesenskii* for this beautiful insect; and therefore I follow Mr. Edwards in admitting the Report of the Secretary of the French Entomological Society upon Dr. Boisduval's exhibition. But this Report, which briefly characterizes the species, can in no way be fairly quoted as Boisduval's; in fact there is not a particle of evidence to show that the worthy Doctor did more than exhibit the specimens, and express his intention of describing them at a future time. It appears, however, that the Secretary, M. Desmarest, by the insertion of a brief comparative description in his report, was just in time to save the name proposed by M. Boisduval, though at the same time unintentionally depriving him of his species: had M. Boisduval placed a written description in the hands of the Secretary, he would have retained his authorship. It is a singular fact that M. Boisduval quotes the volumes for both 1854 and 1855, and p. lii instead of p. xxxii of the latter volume. In these errors he has been followed by both Edwards and Kirby.

48. SYNCHLOE OCCIDENTALIS.—Pieris occidentalis, *Reakirt, Proc. Ent. Soc. Phil.* vi. p. 133 (1866). Mendocino and Siskiyou Counties.

Mr. Edwards only quotes the 'Proceedings of the Academy of Natural Sciences' for the same year (1866); but on referring to it (p. 238), I find nothing beyond the name of the species and an imperfect reference to the then unpublished description above quoted.

49. Synchloe vernalis.—Pieris vernalis, *Edwards, Proc. Ent. Soc. Phil.* ii. p. 501 (1864). Mendocino County.

Mr. Godman also possesses a small and rather dark-coloured female specimen. Is it *P. sisymbrii*? The North-American species appear to run very close.

50. Synchloe venosa?—Pieris venosa, *Scudder, Proc. Bost. Nat. Hist. Soc.* viii. p. 182 (1861). One male, Mendocino County.

51. Neophasia menapia.—Pieris menapia, *Felder, Wien. ent. Monatschr.* iii. p. 271. n. 18 (1859); *Reise der Nov. Lep.* ii. p. 181. n. 172, pl. 25. fig. 7. Mendocino County and Mount Shasta.

52. Euchloe sara.—Anthocharis sara, *Lucas, Rev. Zool.* 1852, p. 339; *W. H. Edwards, Butt. N. Amer.* i. *Anth.* pl. ii. figs. 1–5 (1871). Mendocino County, California.

53. Euchloe Reakirtii. — Anthocharis Reakirtii, *Edwards, Trans. Am. Ent. Soc.* 1869, p. 368; *Butt. N. Amer.* i. *Anth.* pl. i. figs. 1–4 (1870). Mendocino County, California.

54. Euchloe lanceolata. — Anthocharis lanceolata, *Lucas, Rev. Zool.* 1852, p. 338; *Strecker, Lep.* p. 49, pl. 6. figs. 6, 6*a* (1873). Mendocino County, California.

55. Euchloe hyantis.—Anthocharis hyantis, *W. H. Edwards, Trans. Am. Ent. Soc.* iii. p. 205 (1871). Mendocino County.

There can, I think, be no doubt that this is Edwards's species; but had I described the species, I should have said that the under surface of the secondaries was rather sap-green, blotched and spotted with silvery white, than simply "white, covered with confluent patches of yellow-green, powdered with grey;" the green portion of the wing prevails over the white. However, this is merely a matter of taste.

Papilioninæ.

56. Parnassius clarius.—Doritis clarius, *Eversmann, Bull. Mosc.* 1843, p. 539, pl. 9. figs. 1 *a–c*. ♂ ♀, Mendocino and Siskiyou Counties.

Lord Walsingham obtained a long series of this species; and

with them I found seven examples evidently referable to the *P. clodius* of Ménétriés, as figured by Mr. Edwards in his magnificent work. Whether these examples really represent a distinct species, I leave those to decide who may have opportunities for breeding them: I am decidedly inclined to the belief that they do.

57. Parnassius clodius, *Ménétriés, Cat. Mus. Petrop. Lep.* i. p. 73. n. 109 (1855); *Edwards, Butt. N. Amer.* i. *Parn.* pl. i. figs. 5, 6 (1871). Sonoma, Mendocino, and Siskiyou Counties.

I detect the following marked differences between the two forms:—*P. clarius* ♂ has no red markings at base of secondaries below; the absence of such markings is noticeable both in Eversmann's and Edwards's figures; the female, however, has these markings well developed, and has all the bands beyond the cell of primaries above carried across these wings to inner margin. *P. clodius*, on the other hand, has the two sexes much alike in pattern, their upper surface being very similar to the male of *P. clarius*, and the under surface of secondaries showing red basal spots in both sexes. The range of *P. clodius* seems to be more extended than Mr. Edwards believed.

58. Papilio philenor, *Linnæus, Mant. Plant.* p. 535 (1771); *Smith, Abbot, Lepid. Insects Georgia*, i. pl. 3 (1797). Mendocino and Lake Counties in June.

59. Papilio zolicaon, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 281. Mendocino County.

60. Papilio albanus (=? P. eurymedon, *Boisd.*), *Felder, Reise der Nov. Lep.* i. p. 93. n. 71 (1865). Mendocino County.

It seems likely that this is only a variety of the following.

60*a*. Papilio rutulus, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 279. Lake and Tehama Counties.

61. Papilio turnus, *Linnæus, Mant. Plant.* p. 536 (1771); *Boisd. & Leconte, Lép. Am. Sept.* p. 19, pls. 6, 7 (1833). Mendocino and Tehama Counties.

Mr. Godman also sends the following species:—

62. Papilio indra, *Reakirt, Proc. Ent. Soc. Phil.* vi. p. 123 (1866). Siskiyou County.

"A rare insect; differs from typical examples in the two yellow spots in the cell of the primaries being almost obsolete."

HESPERIDÆ.

63. Goniurus tityrus.—Papilio tityrus, *Fabricius, Syst. Ent.* p. 532. n. 382 (1775); *Smith, Abbot, Lepid. Insects Georgia*, i. pl. 19 (1797). Mendocino County.

64. Pamphila napa.—Hesperia napa, *W. H. Edwards, Proc. Ent. Soc. Phil.* iv. p. 202, pl. i. figs. 3 & 4 (1865). One male, Shasta County, in July.

65. Pamphila sylvanoides.—Hesperia sylvanoides, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 313. Sonoma, Mendocino, and Siskiyou Counties.

The female described by Boisduval is probably an insect received under the name '*P. sylvanoides*' from a French dealer, and which is a male considerably larger than either *P. sylvanus* or *P. sylvanoides*.

66. Pamphila nemorum.—Hesperia nemorum, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 314. Mendocino County.

67. Pamphila columbia, *Scudder, Fourth Rep. Peab. Acad. Sci.* for 1871, p. 77. n. 2 (1872). Shasta County.

This species has been confounded with our European *P. comma*, from which it is easily distinguishable.

68. Pamphila melane?—Hesperia melane, *Edwards, Trans. Am. Ent. Soc.* ii. p. 312. Mendocino County.

69. Pyrgus ruralis.—Syrichtus ruralis, *Boisduval, Ann. Soc. Ent. France*, 1852, p. 311. Mendocino County.

70. Pyrgus syrichtus.—Pamphila syrichtus, *Fabricius, Syst. Ent.* p. 534. n. 394 (1775). Sonoma and Shasta Counties.

71. Thanaos juvenalis.—Hesperia juvenalis, *Fabricius, Ent. Syst.* iii. 1, p. 339. n. 291 (1793). Sonoma and Mendocino Counties.

72. Thanaos ennius.—Nisoniades ennius, *Scudder & Burgess, Proc. Bost. Nat. Hist. Soc.* xiii. p. 296, fig. 9 (1870). Sonoma and Mendocino Counties.

I strongly suspect the two preceding forms to be slight modifications of the same species: the fact that they are usually placed together in collections under the name of "*Nisoniades propertius*," Scudder (with which name the present series was labelled), shows how much Scudder's genital distinctions can be

depended upon as specific characters. I have named *T. ennius* by comparison with specimens separated in our collection by the author of the species when last in England.

73. Thanaos tristis, *Boisduval, Ann. Soc. Ent. France*, 1852 p. 311. Mendocino County.

Mr. Godman adds the following species :—

74. Carterocephalus omaha.—Hesperia omaha, *Edwards, Proc. Ent. Soc. Phil.* ii. p. 21 (1863). Siskiyou County.

"Very like our English species."

On Indications of the Sense of Smell in *Actiniæ*. By Walter Heries Pollock; with an Addendum by George J. Romanes, LL.D., F.R.S., Sec. Linn. Soc.

[Read June 15, 1882.]

About two years ago, when I was staying on the west coast of Scotland, I spent a morning among the rock-pools left by a receding tide. Many of these pools were occupied by specimens of the common Sea-anemone lying in circles; and presently something in the behaviour of these creatures attracted my notice. This was that they appeared to become conscious of the presence of any kind of food (pieces of Mussel, Limpet, &c.) which I placed near them. If this was held near an individual Anemone the creature opened; if it was held in the centre of one of the circles the Anemones gradually opened in succession. Thinking that a burst of sunlight, coinciding with the offer of the bait, might have something to do with this, I repeated the process in pools shaded from the sun, with the same result. Pieces of stick or stone placed in the water (if placed, that is, so as to make a considerable disturbance) seemed to make some slight agitation, which, however, soon subsided; if placed so as to avoid any disturbance they had no visible effect.

I told my friend Mr. Romanes some time afterwards what I had observed. He, I believe, first verified my observations for himself, and then proposed that we should repeat the experiment together. This we did at the Aquarium of the London Zoological Gardens, and afterwards at the Crystal-Palace Aquarium. Mr. Romanes provided for the experiment some morsels of Cockle, which we attached to threads. Some of these morsels we sus-

pended in the water, others we placed on the floor of the tanks. At neither aquarium were the creatures in a lively state; and at the Crystal Palace many of them were sloughing; but the result of many trials convinced us that the Anemones certainly were conscious of the presence of the stuff, the consciousness being shown by gradual opening. The greatest distance from the bait at which we found this consciousness displayed was a span's breadth. In one case which we watched for a considerable time, the Anemone opened somewhat rapidly, and for some time seemed, as we judged from the motions of its tentacles, to be trying to determine in what direction the bait lay, and finally rested with its tentacles spread out in a wrong direction. In another case, that of a large and unhealthy-looking Anemone, the presence of the food seemed to excite repulsion, as some minutes after the bait had been laid down, the creature, which was to begin with and throughout remained half open, had bent itself away from the piece of Cockle which was put within about two inches of it. On the whole, our impression was that the creatures knew that food was near them, but could not distinguish, unless it was quite close to them, in what direction it lay.

Addendum by George J. Romanes, LL.D., F.R.S., Sec. L.S.

As Mr. Pollock has referred to my name in connexion with his paper, I should like to make a few remarks upon the results which his experiments have yielded.

There can be no question at all concerning the truth of the facts; and they apply equally to all the species of *Actiniæ* which we have had the opportunity of observing.

The sense which is thus shown to be presented by these animals may most properly, I think, be called a sense of smell; and they are the lowest animals in which any such sense has hitherto been noticed. It was not found practicable to determine by experiments whether the sense is restricted to any special part of the organism, or is diffused over the whole; for this could only be determined by section, and section has the effect of making Sea-anemones close so firmly, that no inference could be drawn from the fact of their subsequently failing to expand when food was placed in their vicinity.

That their sense of smell does not enable the animals to localize the direction in which the food is lying, is not remarkable; indeed it would only be remarkable were the fact other-

wise. For it is not possible that any animal should be able to ascertain the direction of a source of smell, unless the animal, being freely locomotive, is able, by moving about, to perceive the differential intensity of the olfactory sensation as it approaches or recedes from such a body. But a Sea-anemone, being stationary, has no opportunity of thus distinguishing the direction from which the odour is proceeding; it can only be affected by the odour as this occurs pretty equally diffused around its own organism.

Note on a new Ciliate Infusorian allied to *Pleuronema*.

By FREDERICK W. PHILLIPS, F.L.S.

[Read June 15, 1882.]

CALYPTOTRICHA *, n. gen.

Animalcules *loricate, sedentary,* more or less ovate or pyriform, clothed with flexible, non-vibratile, setose ciliæ. Oral aperture ventral. A vibratory membranous hood or velum. Contractile vesicles and nucleus present, and trichocysts in cortical layer.

CALYPTOTRICHA PLEURONEMOIDES †, n. sp.

The adult form provided with an elongo-ovate, transparent, hyaline lorica, opening teat-like at both ends. Body-cilia about two thirds the body in length, with shorter, stronger vibratile cilia at entrance of velum; the velum almost equal to the ventral length. Nucleus centrally situate, and two rhythmically contractile vesicles present. Anterior extremity of body protrusible from lorica. Length ·001 inch.

Hab. Pond-water.

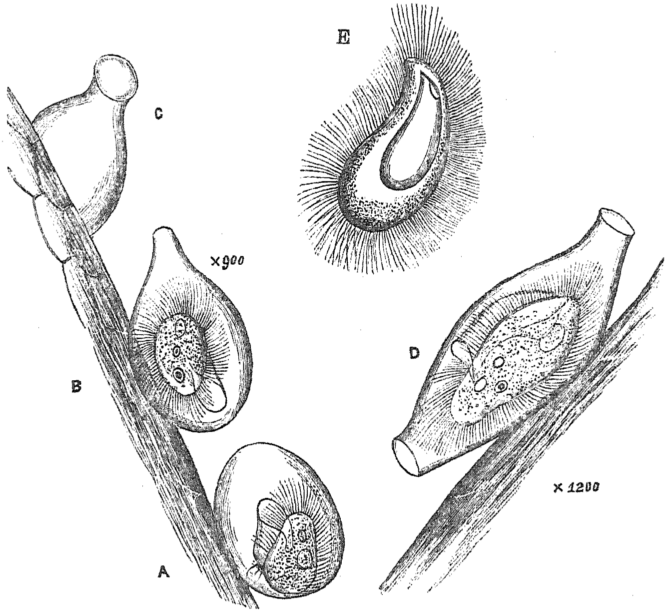
The above-named animalcule, which is now described for the first time, was found attached to *Myriophyllum*, obtained from a pond near Hertford. At first sight I thought it was an embryonic or encysted stage of some monad; but upon applying a magnifying-power of some 900 diameters, I observed that it possessed a singular vibratile membrane, closely resembling that which characterizes the members of the family Pleuronemidæ.

I observed that the animalcule was of an ovate form, the body being clothed with numerous long, flexible, but non-vibratile cilia, of a setose character; that the membranous trap, or *velum*, which in form resembled the old-fashioned poke-bonnet, con-

* καλυπτός, veiled or covered; θρίξ, hair.

† Trivial name in allusion to its resemblance to the genus *Pleuronema*.

stantly vibrated backwards and forwards; that the movements of the animalcule consisted of rapid and continuous revolutions



Calyptotricha pleuronemoides, nob., in different stages of development. A. First stage. B. The same, further developed. C. End view of lorica. D. The perfect animal, like the others adherent to the leaf of *Myriophyllum*. E. Diagrammatic sketch of a momentary view obtained of the ventral surface in the act of protrusion; the velum is drawn backwards.

Drawn from nature and all highly magnified.

on its longitudinal axis; also that it was enclosed in an oval, imperforate, hyaline cyst or lorica. This first observation was made on March 16th.

On March 23rd I discovered that the lorica had increased in size, and that one end was elongated into a teat-like form; the contained animalcule had also increased in size, and a slight depression was visible on the ventral side at the entrance to the velum. At this stage, by an accident, the slide on which the animal was living became dried up, and I was unable to follow its further development.

On March 28th I found several other specimens, one of which had developed a most remarkable lorica, open at both ends, and of a symmetrical form. The enclosed animalcule was of a larger size than those previously examined. The body was somewhat

pyriform; the velum was greatly elongated, extending almost the entire length of the ventral surface; in width it had not increased proportionately.

The body-cilia were about two thirds of the diameter of the body in length; several shorter, powerful, vibratile cilia were stationed along the entrance of the velum; two rhythmically contractile vesicles were present, also a nucleus centrally situate. Owing to the great activity of the animalcule, I could not make out the oral aperture satisfactorily. I endeavoured to feed it with carmine, but was unsuccessful, because of its awkward situation in the fork of the weed; but occasionally particles of matter passed over the outermost aperture of the lorica, which were rapidly swept within. The hyaline membrane vibrated continually as before; and I am inclined to think it is an active agent in procuring food. Trichocysts were developed in the cortical layer.

Its movements were much the same as before, except that they were more vigorous; and occasionally the anterior extremity would be protruded from the lorica; it would also occasionally reverse its position in the lorica.

The nearest ally of the present species appears to be found in the typical genus *Pleuronema*, of the family Pleuronemidæ, which is defined in Mr. Saville Kent's 'Manual of the Infusoria,' vol. ii. p. 542 (pt. 4, 1881); but from all specific forms of which it differs in the possession of a membranous lorica.

In his description of the family and genus (*op. cit.*), the animalcules are described as essentially free-swimming. But I have no reason to believe that the present species ever quits its habitation to assume the habitual free-swimming character of all the Pleuronemidæ previously recorded, nor have I ever seen an empty lorica. I am further of opinion that this sedentary stage is the mature condition.

Mr. Kent remarks of *Pleuronema* (*l. c.* p. 543) that the trap may be compared to the extensile hood of a carriage, or an outside window-shade, and, when not in use, is packed in neat folds round the animalcule's mouth. I may mention, however, that I have never observed any retraction of the hood-like process in *Calyptotricha*.

This peculiarity, its sedentary habit, and the presence of a lorica sufficiently, therefore, distinguish it from the genus compared.

I am indebted to Mr. Kent for kindly looking over my notes, and suggesting the generic and specific names here given.

Notice of the Discovery of Remains of the Great Auk or Garefowl (*Alca impennis*, L.) on the Island of Oronsay, Argyllshire. By Symington Grieve, Esq. (Communicated by Dr. J. Murie, F.L.S.)

[Read May 4, 1882.]

(Plate IX.)

Trustworthy evidence goes to prove that the so-called Great Auk or Garefowl (*Alca impennis*) has been extirpated within the memory of living men—the very last living ones being recorded as taken in Iceland about 40 years ago, while still earlier in the present century stray examples were got within the British area. For the history and distribution of the bird, however, I need only refer to the able writings of Professors Steenstrup*, Newton †, and others ‡; and for an account of its osteology to Prof. Owen's memoir § on the Newfoundland specimens. Its remains in the kitchen-middens of Denmark, Iceland, and North America are authenticated; but only in two instances have prehistoric remnants been found in Britain, viz. 2 humeri, 2 tibiæ and fragments, and portion of a premaxilla by Mr. S. Laing, at Caithness, and the front moiety of a sternum afterwards obtained from the same place by Dr. J. Anderson ||.

(Since the above was written, my attention has been called to the Nat. Hist. Trans. of Northumberland and Durham, vol. vii. part ii. (1880), pp. 361–364, where it is mentioned some Garefowl-remains were found in a limestone cave near Cleadon, on the Durham coast, during 1878.)

The rarity of this interesting avine form, and the fact of its

* "Et Bidrag til Geirfuglens" &c., in 'Videnskabelige Meddelelser' for Aaret 1855 (Kjöbenhavn, 1856–57), pp. 33–116.

† Ibis, 1861, pp. 374–379, 1870, p. 256, and Encycl. Brit. 9th ed. 1875, article "Birds."

‡ Among these may be mentioned "The Gare-Fowl and its Histories," Nat. Hist. Rev. 1865, p. 467; and 'Ueber *Plautus impennis* von W. Preyer,' 1862, for a separate copy of which I am indebted to the author since the reading of the present paper.

§ Trans. Zool. Soc. vol. v. p. 317 (1865).

|| Consult 'Prehistoric Remains of Caithness,' 1866, by Samuel Laing, M.P.; also "Notice of the Remains of Garefowl in Scotland," by Dr. J. Alex. Smith, in Proc. Soc. Antiquaries Edinb. 1879, pp. 76–105. The portion of sternum in Mus. Coll. Surg. Lond. is numbered 1150 B, and was presented by Mr. G. Busk, through Dr. J. Anderson, and got at Keiss, Caithness.

being obtained in a new locality along with other animal débris under peculiar conditions, warrant my offering the present contribution to the Society.

During the summer of 1879 the writer formed one of a small party who visited the island of Colonsay, to which is attached at low water the islet of Oronsay, the intervening strand being dry for about three hours each tide. Finding we had entered upon a new field for study, we began to make a list of the flora, which has been published in the Trans. Bot. Soc. Edinb. (vol. xiv. parts 1 & 2). In the beginning of May 1880 we returned to the islands, and were struck with the remarkable appearance of a cone-shaped mound, on the eastern side of Oronsay. We shortly afterwards learned that Pennant, when he visited the island in 1772 *, had noticed the place, and describes it as a tumulus. Our repeated inquiry among the islanders as to what the mound was, or if they knew any tradition regarding it, resulted in their only knowing it by the name of Caisteal-nan-Gillean †.

Having in the winter following made the acquaintance of Mr. William Galloway, well known for his antiquarian researches in Scotland, and finding that some years previously he had visited Oronsay, we agreed to revisit the island, and did so early in June 1881, in company with Mr. Alex. Galetley, curator of the Museum of Science and Art, Edinburgh.

Permission to make an excavation having been granted by Mr. Malcolm McNiell, the brother of the proprietor of the islands (Sir John Carstairs McNiell, V.C.), we proceeded forthwith. Our cutting was commenced at the base, and we worked inwards, but found the labour toilsome, and even dangerous, as large quantities of sand were continually falling overhead. At last we found it impossible to work straight in upon the same level on which we started, and had gradually to work upwards, keeping the bottom of our trench about ten feet from the surface as we steadily excavated towards the middle of the mound.

While we were engaged in digging, Mr. Galloway was busy measuring and marking off the ground. He ascertained that the hillock is 150 feet in diameter, and nearly circular in form, the height being about 30 feet on the eastern side, which gives the greatest elevation, as the ground rises considerably on the west. On the south-east of the mound there is a sand-pit, whence pro-

* Pennant, 'Tour through the Western Isles,' Lond. 1772.

† In the Gaelic literally the Castle of the Servants (Gillies or followers).

bably has been derived the sand which covers all but the inner crust of this remarkable hillock. At the end of three days, we found we had made a cutting about 70 feet in length, and were close to the apex. By this time we had discovered abundance of shells, a few bones, and some rough stone implements, and with these we started for Edinburgh. Of this material Mr. Galetley undertook examination of some, and Dr. Traquair, F.R.S., and his assistant, Mr. John Gibson, identified others. The two latter gentlemen simultaneously were struck with the remarkable form of a humerus of a bird, and guessed it to be that of the rare and extinct Garefowl, which surmise turned out to be correct.

The mound of Caisteal-nan-Gillean, on Oronsay. The "Paps of Jura" and N.E. extremity of Islay in the distance. From a photograph by Mr. Galloway, reduced.

This discovery gave so much encouragement, that it led us to make arrangement to return to Oronsay in August and continue the excavations. Mr. Galloway started about the middle of the month, and remained working for six or seven weeks; I was fortunate in being able to spend about a week in his company.

During this visit we were employed removing the upper part of the mound, where the greatest deposits existed, as our expe-

rience showed us that if it had been raised over any thing, or was the superstructure covering a place of interment, we could only ascertain this by digging down to the living rock, which is about 3 feet below the original level of the sand at the outer edge of the mound, and possibly is the same under the apex. As the falling sand made this work very dangerous, we proceeded to remove about 12 feet of the upper part of the hillock, and then to dig downwards, as circumstances permitted. By the end of September fully one third of the apex had been dug off, and every spadeful most carefully examined, so that not even the minutest object could be passed. The same rule has been followed all through; and though the work went on so much more rapidly during our first visit, it was entirely owing to the fact that we had mostly pure sand to deal with: this contained not a vestige of remains, and seemed as if deposited from the sand-pit. To give some idea of the nature of the deposits as revealed by the sections examined during the digging, we may state that the outside of the cone is covered with grass, and beneath this with turf and blown sand to a depth varying from one to five feet, the greatest depth being at the north side of the apex * and gradually thinning off all round to the outer edge. Below that is a series of strata, composed principally of shells, which taper off from the apex similar to the upper deposit, and underneath these is pure sand. Where we began our excavations we found almost solid sand; then, after a few feet, we came upon a thin layer of shells near the surface, which was at first only about an inch thick, but as we worked inwards we found this line gradually getting thicker, until near the summit it was composed of numerous layers which were pretty clearly defined, though here and there they ran into each other, and altogether were about 8 feet from top to bottom.

The greater part of the shells were those of the Limpet (*Patella vulgata*, L.); however, others were intermixed; and besides these were a few bones, bone-implements, and oblong water-worn stones of a slaty character, some of which, we suppose, have been used as limpet-hammers, which we shall speak of presently. Others have one end rubbed so as to form an edge, and are similar in appearance to prehistoric implements from the Swiss lake-dwellings, and also from Orkney, Shetland, and Wigtonshire. There are also a few oval and nearly round stones that showed

* The strong south winds have blown the sands northwards, causing the accumulation on that side of the mound.

marks of having been used for striking, along with some stone-heaters cracked by the action of fire, and, in addition, a few pieces of flint of small size. Of bone-implements we got several, but all in a fragmentary state. They consisted of two harpoon-heads (the one opposite, and the other alternately barbed), one bone-awl in a perfect state, and the point of another; also a number of bones rubbed at one end, some on both sides, so as to give an edge, and others only on one side; but most likely they were used for different purposes, as those rubbed flat only on one side are larger, and made of selected pieces of the bones of Red Deer, while some of those with the rubbing on both sides, so as to form an edge, are made of the same material; portions of smaller bones have been used. In digging we came across some large flat stones, which had evidently been used as hearths; for they had charcoal and burnt material around them, but not in sufficient quantity to give the impression that they had been used for any great length of time; and it was generally in the immediate neighbourhood of those ancient fireplaces that we got the implements. The charcoal is very soft, and has the appearance of having resulted from the burning of a soft wood. In the bed of Loch Fada, in Colonsay, are stumps of immense trees that may at one time have furnished the inhabitants with fuel. Being desirous to ascertain whether the charcoal and the wood from these tree-stumps agreed in structure, we placed specimens of each in the hands of Mr. J. M. Macfarlane, B.Sc., Assistant to the Professor of Botany in the University of Edinburgh. He has identified the wood as that of the Goat Willow * (*Salix caprea*, L.), though it is difficult to say categorically whether this and the charcoal are identical.

The remains in the lowest deposits near the summit differed in some respects from those found nearer the surface. All are of a very rough description, indicating that the mound was used by a primitive and probably ancient people. In fact the question naturally arises, What can there be underneath that would account for this sand-hill? The latest excavations, carried on during the month of March this year (1882) by Mr. Galloway, show that the sand below the strata in which we have found the remains is not one vast homogeneous mass that has been accumulated at one time, but is all blown or drift sand laid in regular layers, the upper part of each defined by a thin line of dark mould, with a

* In the Hebrides the willow was used for making bridles, ropes, and tackle of every variety.

few sea- and land-shells intermixed; but no implements or other remains have yet been met with in these lower deposits. The conclusion that all seems to point to is, that the lower part of the Caisteal-nan-Gillean has been formed by natural, and not human agency.

Garefowl-bones described by Mr. Gibson (see Plate IX.):—

1. *Right humerus*, measuring 4 inches in length, and 1 inch in breadth at the proximal end. The compressed shaft at its middle portion measures 6 lines in long diameter, and nearly 3 lines in short diameter. According to Professor Owen (Trans. Zool. Soc. vol. v. p. 327), there is a thick ridge or raised rough surface near the radial end of the articular head of the humerus, extending about 8 lines down the bone, which gives insertion by a well-marked narrow elliptical depression to the second pectoral muscle, the raiser of the wing. In the present specimen the bone of the ridge exhibits a diseased condition, the normal depression being changed into a deep trough 8 lines in length and 4 lines broad.

2. *Proximal half of right humerus.*—Total length of specimen $2\frac{1}{2}$ inches; broken about the middle of the shaft, which exhibits medullary cavity. This cavity measures $2\frac{1}{2}$ lines in long diameter by 1 line in short diameter, the shaft measuring similarly 6 lines by $2\frac{1}{2}$ lines.

3. *Distal half of left humerus.*—Specimen measuring 2 inches 2 lines; shows medullary cavity. In this specimen the condyle and the three anconeal ridges are very perfect.

4. *Distal end of left humerus*, 3 inches in length.

5. *Left coracoid bone*, with a total length of 2 inches 4 lines. At the sternal end it is 10 lines in breadth; but as both ends are imperfect, it probably had a breadth of at least 1 inch. The thin lamelliform process given off above the sternal articulation is also gone; otherwise the coracoid is entire. From the sternal end it gradually contracts to 5 lines, then widens out, giving off a strong, compressed process, which is perforated.

6. *Upper half of right coracoid.*—Specimen $1\frac{1}{4}$ inch in length, ending a little below the perforated process.

7. *Distal end of right tibia.*—Specimen 1 inch in length; shaft showing very minute medullary cavity.

8. A dorsal vertebra.

In addition to the above, Mr. Galloway has likewise discovered a number of other remains, among which we may mention several

upper and lower portions of humeri, lower ends of tibiæ, and entire femora, &c.

We have therefore doubtless the bones of a large number of Garefowl and aquatic birds.

The following is a list of the other animal-remains from the mound:—

Mammals.

Cervus elaphus, L. Red Deer. Many of the bones have been rubbed.
Martes foina, L. Marten.
Lutra vulgaris, Erxl. Otter.
Ovis aries, L. Sheep. We have only one portion of a bone that we are certain belongs to this animal; and it was found near the upper surface of the deposits, and is in better preservation than the other remains, which may indicate it is more recent.
Mus decumanus, Pall., or *rattus*, L. Rat.
Lepus cuniculus, L. Rabbit. Found in old burrows; and the remains appear to be recent.
Phoca vitulina, L. Common Seal.
Sus scrofa. Pig.

Birds.

Uria troile, L., or *grylle*, L. Guillemot. And several other shore-frequenting birds, of which furculæ, coracoids, scapulæ, humeri, and femora remain for the present undetermined.

Fish.

Labrus maculosus, Bl. Wrasse.
Mugil septentrionalis, Günth. Grey Mullet.
Acanthias vulgaris, Risso. Picked Dog-fish.
Raja batis, L. Skate.

Crustaceans.

Platycarcinus pagurus, Edw. Crab.

Shells.

Patella vulgata, L. Limpet.
Pecten opercularis, L. Scallop.
Ostrea edulis, L. Oyster.
Buccinum undatum, L. Horse Whelk.
Littorina littorea, L. Periwinkle.
Cyprina islandica, L.
Lævicardium norvegicum, Spengl.
Axinæa glycymeris, L.
Cardium edule, L. Cockle.
Tapes pullastra, Mont.
T. virgineus, L.
Venus casina, L.
Ensis siliqua, Linn.
Trivia europæa.

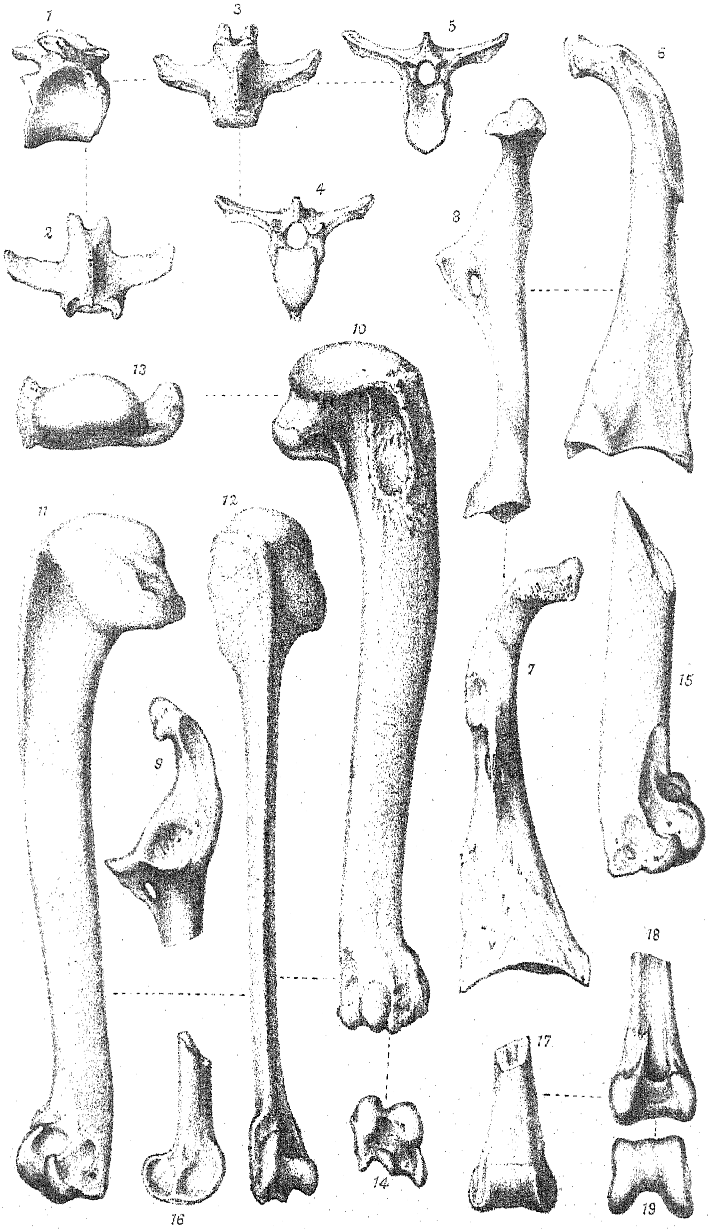
With regard to these remains, we may observe that the bones of the Red Deer, though found all through the strata, even in the highest, were most plentiful in the lower deposits, and seemed to become much less common in the upper layers. It would seem that this probably indicates that the animal was becoming gradually less abundant during the period that Caisteal-nan-Gillean was inhabited. We may also remark that, as in our excavations at the Crystal-Spring Cavern, Colonsay, we only found the bones of the Red Deer in the lowest deposits of the cave-floor, it appears therefore that there is good reason to suppose that the

time at which the upper deposits at the mound were formed and the earliest deposits of the cave is about the same. Moreover, as the Deer-remains in the cave are not found very frequent, it is quite possible it was only occupied after the mound had ceased to be a place of human residence. If our conclusions upon this point be correct, the mound must have been occupied at a very early period in the history of the isles, as we find in the upper deposits of the cave-floor, and above the strata in which we have found the Deer-bones, other remains which point to these having been formed during the Danish or Norwegian occupation of Colonsay and Oronsay.

Another evidence of the antiquity of the mound is in the absence of Ox-remains, which are met with in the upper deposits of the cave under stalagmite. The remains described as those of the Pig may possibly belong, not to the domestic Hog, but to the Wild Boar. As Sir John Lubbock remarks*, Professor Steenstrup does not believe that the domestic Hog is represented by its remains in the Danish shell-mounds; and, besides, one of the rib-bones in our possession bears evidence of having been broken and afterwards having united, and such an injury, it seems to us, would most likely be received in the chase.

One remarkable feature of the deposits at Caisteal-nan-Gillean is the immense number of Limpet-shells, very many with small holes in them, caused, we believe, by the stroke of the rough stones used as hammers to knock them off the rocks. Almost all the stone-implements are just suitably-shaped stones taken from the beach; but nearly all those found in the neighbourhood of the hearths bear marks of having been rubbed at the one end, and, with two exceptions, are all small, varying from 2 to 3 inches in length; while many of the stones we call limpet-hammers are quite a foot in length, and, with the exception of being sometimes fractured at the ends, bear no evidence of having been used. Nearly all these are found lying among the thinner deposits of shells away from the centre of the mound, as if they had been thrown there to be out of the way from the hearths. Our reason for calling them limpet-hammers is as follows:—We had been making inquiries among the islanders for those implements, but without success, as we understood they were carefully fashioned or selected stones that were handed down by the fishermen from father to son; and we found that most of

* 'Natural History Review,' 1861, p. 497.



Berjeau lith. BONES OF GREAT AUK, Nat. size. Hanhart imp.

the men used the blade of an old reaping-hook to knock the Limpets off the rocks. However, we also discovered that, failing an instrument of that kind, they then took an oblong-shaped stone from the beach. The second day of our excavations at Caisteal-nan-Gillean we were puzzling ourselves as to what could be the use of the numerous oblong stones we met with among the shells, and mentioned the matter to our workman, who was accustomed to go to the fishing, and he seemed, just as a matter of course, to inform us that they were limpet-hammers. He assured us that he and his fisher-mates often took such stones from the beach when proceeding on a trip, and would retain the stone for collecting bait until the end of their fishing, when they would throw it away. Subsequent inquiries have only helped to confirm us in the opinion that the large oblong stones found at Caisteal-nan-Gillean are really limpet-hammers. We understand that similar stones have been found in the ancient kitchen-middens of other localities, and have proved a puzzle to antiquarians; but we think what we have stated will be found to be the real solution of the mystery.

DESCRIPTION OF PLATE IX.

All the bones are drawn of natural size.

Figs. 1–5. Dorsal vertebra shown in its different faces:—1, side view; 2, from above; 3, from below; 4, in front; 5, from behind.

Figs. 6–8. The entire left coracoid in three aspects:—6, exterior; 7, interior; 8, its antero-inner edge.

Fig. 9. Upper moiety of right coracoid, viewed from the front and inside.

Figs. 10–14. Different views of the right humerus:—10, posterior surface; 11, anterior surface; 12, external front edge; 13, superior condyloid extremity; 14, inferior condyloid extremity.

Fig. 15. Distal segment of left humerus.

Figs. 16–19. Different views of the distal end of the right tibia:—16, interior; 17, posterior; 18, anterior; and 19, the inferior face.

Descriptions of new or little-known *Comatulæ*.—I. & II. By P. Herbert Carpenter, M.A., Assistant Master at Eton College. (Communicated by Dr. W. B. Carpenter, C.B., F.R.S., F.L.S.)

[Read June 1, 1882.]

The two following articles are the commencement of a series which I propose to offer to the Society from time to time, containing descriptions of *Comatulæ* that are either entirely new or but little known to zoologists. In all the principal museums of the Conti-

nent that I visited in the summer of 1880, I found great numbers of undescribed *Comatulæ* from very various localities. Some few of these I have worked out already*, while others are described in the following pages; and I hope in course of time to be able to take advantage of the courteous offers that have been made to me, and describe those that are as yet unnamed. They are very numerous, however; and when my descriptions of the hundred odd 'Challenger' species shall have been published, there will yet remain some fifty more, from the dredgings of the U.S. Coast Survey, to be worked out. Even after making allowance for the immense amount of local variation which occurs in the group, I should estimate it to contain at least four hundred species. Only thirty of these were described by Müller; and since his time less than twenty had been described by other naturalists up to the time when I began to work at the group, rather more than six years ago. Roughly speaking therefore, and apart from the 'Challenger' and 'Blake' collections, there remain some two hundred species yet to be described; so that a very long time must necessarily elapse before it is possible to make out a check-list of the *Comatulæ* like the admirable one of the Ophiurids which Mr. Lyman has published.

I have often wondered why the family has been so entirely neglected since the time of Müller; but the result is very advantageous to present workers in one point, viz., the very small amount of literature that has to be consulted. On the other hand, it is no easy task to draw up a satisfactory scheme of classification for four hundred species, more than nineteen-twentieths of which belong to but two genera. Only three species of *Promachocrinus* are known, and three of *Atelecrinus*. These last, together with the four species of the genus *Eudiocrinus*, are described in the following pages.

I. On the Species of Atelecrinus and Eudiocrinus†.

Genus Atelecrinus, *P. H. Carpenter*, 1881‡.

Centrodorsal acorn-shaped, and bearing five vertical double rows of cirrus-sockets, those of each row alternating with one another and with the sockets of adjoining rows. They have horseshoe-shaped rims, the

* "The *Comatulæ* of the Leyden Museum," Notes from the Leyden Museum, vol. iii. pp. 173-217.

† Published by permission of the Lords Commissioners of the Treasury, and of Carlile P. Patterson, Superintendent of the U.S. Coast Survey.

‡ Bull. Mus. Comp. Zool. vol. ix. no. 4, p. 16.

arches of which are directed upwards, while the two ends slant downwards and outwards. Radials separated from the centrodorsal by a complete circlet of basals. The first six or more brachials bear no pinnules.

Remarks. Three species of this interesting genus are known, two from the Atlantic and one from the Pacific Ocean. One (*A. cubensis*) was dredged near Havana in 1868 by the U.S. Gulf-stream Expedition, though its singular characters were not then recognized. A second species (*A. balanoides*) was first obtained by the 'Challenger' (1873) in the Atlantic, somewhat to the south of Pernambuco. It was subsequently found off the north coast of Cuba by the U.S. steamer 'Blake' (1877–78), and again at four stations in the Caribbean Sea by the 'Blake' Expedition of 1878–79. The remaining species (*A. Wyvilli*) was dredged by the 'Challenger' in the neighbourhood of the Fiji Islands. Only one specimen was obtained, which, like the solitary example of *A. balanoides* from Pernambuco, is very much mutilated. The disk, however, is visible in both, which is not the case with any of the American specimens, though these last have more of the arms preserved.

From a morphological point of view, *Atelecrinus* is by far the most interesting of all the free Crinoids, as has been already pointed out in my preliminary 'Blake' report. The bathymetrical range, as at present known, varies from 291 to 450 fathoms; and it has a considerable geographical extension, occurring in the West Atlantic and Mid-Pacific, though not known as yet from any intermediate localities.

1. Atelecrinus balanoides, *P. H. Carpenter*, 1881.

Antedon cubensis, *Pourt.* (*pars*) *Bull. Mus. Comp. Zool.* vol. v. no. 9, p. 214.

Atelecrinus balanoides, *P. H. Carpenter, Bull. Mus. Comp. Zool.* vol. ix. no. 4, p. 16.

Centrodorsal acorn-shaped, reaching 5 mm. high by nearly 3½ mm. in diameter. It bears five vertical double rows of cirrus-sockets, the upper ends of which are separated by more or less distinct interradial ridges. Four to six sockets in each row, the dorsal pole, though rough, being free from functional sockets. The ends of their horseshoe-shaped rims slant downwards and outwards, but are much more prominent in some individuals than in others.

The cirri have three or four quite short, almost triangular basal joints. The next joint is twice as long as wide, and its successors

are much elongated, reaching $2\frac{1}{2}$ mm., with a slight tendency to overlap one another on the ventral side of the cirrus. There are probably about 35 joints, the length much exceeding the breadth till the penultimate, which is followed by a very small terminal claw. The last six joints taper rapidly.

The basal ring is a very thin plate rising at the interradial angles into triangular elevations, which are produced slightly outwards and rest upon the upper ends of the interradial ridges of the centro-dorsal. First radials broad and tolerably flat, their size varying with the age of the individual. Second radials more arched, oblong, and quite free laterally, their breadth in the adult being one and a half times their length. Axillaries pentagonal, twice the length of the second radials, into which they have a slight backward projection. Their width is about equal to their length, but their proportions and also those of the second radials vary slightly in different individuals.

First brachials well separated laterally, with their inner sides shorter than the more rounded outer ones. Second brachials irregularly quadrate, projecting slightly backwards into the first. The following joints have markedly unequal sides. Except in the syzygial joints the length is at first less than the breadth, but gradually becomes more equal, and exceeds it after the fifteenth joint. Terminal joints relatively longer and more equal-sided. Arm-bases smooth, but the middle and later joints overlap slightly.

The first syzygium on the third brachial. The following syzygia at intervals of from one to six, usually of two or three joints.

First pinnule nearly always on the 12th brachial, and consisting of about a dozen elongated joints. The following ones increase in size and in the number of joints, decreasing again towards the arm-ends. The lower joints of the middle and later pinnules bear irregular spinous processes on their dorsal edges.

Mouth excentric, and surrounded by a large peristome. Immediately behind this is the anal tube, which is thus nearly central. Disk 6 mm. in diameter. In the 'Challenger' specimen a few minute calcareous granules are visible on its ventral surface, and also on its sides between the rays. The 'Blake' specimens are more naked. The brachial ambulacra lie close down upon and between the muscular bundles, and have a few scattered sacculi at their sides. Colour of skeleton white or brownish white.

1873. H.M.S. 'Challenger.' Station 122. Lat. 9° 5′ S. to 9° 10′ S.; Long. 34° 49′ W. to 34° 53′ W. Depth 350 fms. Mud. One specimen.
1877–78. U.S. C.S. str. 'Blake.' Station 43. Lat. 24° 8′ N.; Long. 82° 51′ W. Depth 339 fms. One specimen.
1878–79. Ditto. Station 150. Between St. Kitts and Nevis. Depth 373½ fms. Ooze and coarse fragments of pumice. Two specimens, one of which is young.
Ditto. Station 151. Off Nevis. Depth 356 fms. Two specimens.
Ditto. Station 222. Off St. Lucia. Depth 422 fms. One specimen.
Ditto. Station 260. Off Granada. Depth 291 fms. Fine grey ooze. Two specimens.

The nine individuals of this species which I have examined all agree very well in their general characters, but differ considerably in the relative proportions of the two outer radials and of the lowest brachials. In all of them which have enough of the arms preserved the first pinnule is on the twelfth brachial, except in one arm of one individual, in which the tenth joint bears the first pinnule.

2. Atelecrinus cubensis, *Pourt.*, sp.

Antedon cubensis, *Pourt.* (*pars*) *Bull. Mus. Comp. Zool.* vol. i. no. 11, p. 356; and vol. v. no. 9, p. 214.
Atelecrinus cubensis, *P. H. Carpenter, Bull. Mus. Comp. Zool.* vol. ix. no. 4, p. 16.

Description of an Individual.—Centrodorsal acorn-shaped, 2 mm. high and nearly 2 mm. wide, covered by five double rows of closely-set cirrus-sockets, which extend almost to the dorsal pole. Usually four sockets in each row, with very strongly marked horseshoe-shaped rims, the ends of which stand out prominently, so as to give the surface of the plate a very rough appearance. Its uppermost portion bears no sockets or only very rudimentary ones, and is produced at the interradial angles into five prominent ridge-like processes, which disappear below between the rows of sockets. The basal ring is pentagonal, with its angles so produced as to rest on the upper ends of these ridges. It is of nearly uniform height (·5 mm.) all round the calyx, rising very slightly at the interradial angles.

First radials short, broad, and considerably arched. Second radials twice their length, and rather wider than long, with the distal edges incised to receive the proximal angles of the quadrate axillaries, which are also wider than long.

First brachials well separated laterally, with the inner sides much shorter than the outer ones, which sometimes project

slightly beyond the edges of the axillaries. The distal edge is much incised to receive the strong backward projection of the quadrate second brachial. The following joints have markedly unequal sides, the third (or occasionally the fourth) and the fifth or sixth being syzygies.

Disk naked. Mouth slightly excentric, with the anal tube just behind it. Brachial ambulacra close down upon and between the muscular bundles. Skeleton brownish white.

Off Cojima, near Havana. Depth 450 fms. One specimen.

Although this species was discovered some four years earlier than *At. balanoides*, I have thought it best to take the latter as the type species of the genus, as it is represented by more abundant and better preserved material, the single example of *At. cubensis* having lost all its cirri and all the arms above the first six or seven joints. The specific name was given to it by Pourtales, who referred it provisionally to the type of *Antedon cubensis*, which was obtained in the same dredging. The chief difference between it and *Atelecrinus balanoides* is in the uniform height of the basal pentagon, and the stronger backward projection of the third radials and second brachials into the preceding joints.

3. Atelecrinus Wyvilli*, n. sp.

Description of an Individual.—Centrodorsal acorn-shaped, 4 mm. high by 3 mm. wide. The double rows of cirrus-sockets are well separated from one another by intervening spaces, and do not reach the dorsal pole. Four, or rarely five, sockets in each row, the ends of which stand out prominently and give a serrate appearance to the lateral edge of the plate. The upper portion is uniformly smooth, without any interradial ridges; but the edge is marked by five slight incisions situated interradially.

The basals are nearly uniform in height throughout their whole width, but are somewhat arched in form. The apex of each arch is interradial, and the interval between it and the notched edge of the centrodorsal below is only occupied by perisome. Hence the basal ring is really only in contact with the centrodorsal at its five lowest points, *i. e.* at the interbasal sutures, immediately beneath the middle of each first radial. The latter have exceedingly high muscle-plates projecting inwards; but their dorsal surface is barely half as long as that of the second radials. These are nearly square, but deeply incised to receive the strong back-

* I dedicate this very interesting species to the memory of Sir Wyville Thomson.

ward projections of the axillaries, which are roughly rhombic and slightly wider than long.

First brachials well separated laterally, with the inner sides much shorter than the outer ones, and the distal edges much incised to receive the strong backward projections of the quadrate second brachials. The following joints have markedly unequal sides with syzygies on the third or fourth, and again on the fifth, sixth, or seventh brachials.

Disk almost naked, 4 mm. diameter. Mouth excentric, and surrounded by a large peristome, immediately behind which is the nearly central anal tube. Brachial ambulacra close down upon and between the muscular bundles. Skeleton light brownish white.

H.M.S. 'Challenger.' 1874. Station 174. Lat. 19° 10′ S.; Long. 178° 10′ E. Depth 225, 610, and 210 fms. *Globigerina*-ooze. One specimen.

Atelecrinus Wyvilli differs from the two forms already described in the greater squareness of the second radials, and in the curious relation of the basals to the centrodorsal. They are of uniform height, as in *At. cubensis*, but are not in contact with the centrodorsal at the interradial angles of the calyx, being separated from it on the exterior of the calyx by a gap which is filled up by perisome. Apart from its purely morphological importance, this Pacific species is also interesting as showing the wide distribution of the genus.

Eudiocrinus, gen. nov.

1868. Ophiocrinus, *C. Semper, Wiegm. Archiv,* Jahrg. xxxiv. p. 68.
1869. Comatula (Ophiocrinus), *P. de Loriol, Denkschr. d. allg. schweiz. Gesellsch. f. d. ges. Naturw.* Bd. xxiii. (Zurich, 1869), p. 57.
1879. Ophiocrinus, *P. H. Carpenter, Proc. Roy. Soc.* No. 194, 1879, p. 385.
1879. Ophiocrinus, *P. de Loriol, Monogr. des Crinoïdes fossiles de la Suisse* (Geneva, 1877–79), p. 277.

Centrodorsal and first radials like those of *Antedon*; but the radials bear the brachials directly without the intervention of axillaries, so that there are only five undivided arms. Mouth central. Sacculi abundant, scanty, or absent altogether.

The genus *Ophiocrinus* was established by Prof. Semper in 1868 for an elegant little *Comatula* with five undivided rays, which he had discovered in the Philippine Islands; and in the following year a fossil species was described by De Loriol from the Neocomian of Switzerland. The generic value of the type was

doubted by Schlüter*; and I have myself had some hesitation in regarding it as equivalent to *Antedon*, *Actinometra*, and *Promachocrinus* †. For there is no definite character, except the simplicity of the rays, which can separate *Ophiocrinus* from the ordinary ten-armed *Antedon*; and in one of the three known species of the ten-rayed *Promachocrinus* the rays divide, so as to form twenty arms; while in the two others there are ten undivided rays. But this character alone would hardly justify the separation of the simpler type of *Promachocrinus* from the twenty-armed form; while I have an abnormal specimen of an *Antedon* with only nine arms, owing to one of the rays not dividing, which is the case with all the rays of *Ophiocrinus*.

Nevertheless it sometimes happens that a character which is only of specific value in one type may be of generic value in another; and as four recent species of *Ophiocrinus* are known which range from Japan into the South Pacific Ocean (lat. 37° S.), together with the fossil from the Neocomian of Switzerland, the simplicity of the rays appears to be a character of some morphological importance; and I am therefore disposed to admit the generic value which was originally assigned to it by Semper. Unfortunately, however, this type cannot continue to bear the name by which it has been hitherto known. For Salter, fifteen years previously to Semper's description of *Ophiocrinus*, had designated by the same generic name an obscure Crinoid from the Devonian of South Africa; and the confusion thus existing was increased by the posthumous publication, in 1878, of the late Prof. Angelin's 'Iconographia of the Swedish Silurian Crinoids,' in which the name *Ophiocrinus* is connected with a third and totally distinct type.

Prof. Semper's genus being thus preoccupied, I propose to call the type *Eudiocrinus* (εὔδιος, calm), in allusion to the fact that all the recent species of it which are known to science are limited to the Pacific Ocean.

In its central mouth and in the structure of its calyx *Eudiocrinus* is essentially an *Antedon*. But the sacculi which are usually so abundant at the sides of the ambulacra of this genus are not so constant in *Eudiocrinus*. *E. indivisus* has numbers of them, while they are scanty in *E. varians*, and altogether

* "Ueber einige astylide Crinoiden," Zeitschr. der deutsch. geolog. Gesellsch. Jahrg. 1878, p. 40.

† Quart. Journ. Geol. Soc. vol. xxxvi. p. 41.

absent in the two remaining species, which I have never found to be the case in *Antedon*, though I have examined over one hundred species of this genus.

Genus Eudiocrinus.

I. First two brachials united by syzygy. First pinnule on the second brachial	1. *indivisus*, Semper.
II. First two brachials united by a ligamentous articulation.	
1. First pinnule on second brachial	2. *varians*, n. sp.
2. First pinnule on fourth brachial.	
(i) Disk plated. First brachials nearly oblong	3. *Semperi*, n. sp.
(ii) Disk naked. First brachials trapezoidal	4. *japonicus*, n. sp.

1. Eudiocrinus indivisus, *Semper*, sp.

Ophiocrinus indivisus, *Semper, Wiegm. Archiv*, Jahrg. xxxiv. p. 68.

Description of an Individual.—Centrodorsal small, convex, and bearing about twenty cirri in two marginal rows, the dorsal pole being free from them. Cirri 9 mm. long, of about twenty joints; the third square, or a trifle longer than wide; the fifth is the longest, and the following ones nearly all longer than wide, and overlapping on the dorsal side; penultimate with an opposing spine.

Radials partially visible, and about one third the length of the compound joint formed by the syzygial union of the first two brachials, the second of which bears a pinnule on the left side. Third brachial short, oblong, and bears no pinnule. The next four or five joints nearly oblong, slightly shorter on one side than on the other, which is not so long as the breadth and bears a pinnule. The tenth and following joints have more markedly unequal sides, the longer of which is longer than the breadth. About 120 arm-joints, the middle ones nearly square, and the terminal joints elongated.

Second syzygy on the fifth brachial, the next on the ninth, and the next on the thirteenth (once on the twelfth) brachial; after this an interval of two joints between successive syzygia.

First pinnule (on second brachial) quite small, consisting of about a dozen short joints, the basal ones of which are rather broad. Second pinnule (on fourth brachial) somewhat longer and stouter; the third and fourth very much so, with longer and more massive joints. The next three or four pinnules on either side gradually decrease in size; and the following ones increase

again, the terminal ones being very long and slender, so as to give the arms a very feathery appearance.

Disk lost. Sacculi tolerably close on the arms, but much larger and more closely set at the sides of the pinnule-ambulacra, which have only the very slightest trace of any superficial limestone deposits.

Colour of skeleton brownish white.

Spread 15 centim. Disk must have been somewhat less than 3 mm. diameter.

Locality. Pandanon, near Bohol, Philippine Islands. 30 fms.

The unique example of this species, which was dredged by Prof. Semper at Pandanon, is now in the collection of Dr. Carpenter. Prof. Semper's description of the type is an excellent one; but I have ventured on another in order to add in some points which were not noticed by him, and are of interest in the comparison of *Eudiocrinus* with other *Comatulæ*. It is a very slender and graceful little species, differing altogether in appearance from those dredged by the 'Challenger' which are described below.

2. Eudiocrinus varians, n. sp.

Centrodorsal low, nearly hemispherical, bearing about twenty cirri in two rows which leave the dorsal pole free. Two forms of cirrus occur in the same individual.—(1) With the three basal joints as long or a trifle longer than wide; the fourth considerably longer, and the fifth and next following ones still more so, reaching 3 mm. in length. Terminal joints unknown. (2) Cirrus-joints quite short, the first six about square, and the next six a trifle longer than wide. Remainder unknown. Radials partially visible. First brachials nearly oblong, inclined to be trapezoidal, with small lateral processes which are the edges of the muscle-plates for articulation with the radials. Second brachials also nearly oblong, with traces of a backward process into the preceding joint, a pinnule on the right, and a small process on the left side. The following joints have unequal sides, with a pinnule on the shorter, and a large wing-shaped process on the longer, which ceases on the sixth, or may go on to the eighth joint. Succeeding joints quadrate and unequal-sided, with the pinnule on the longer side. The twelfth and following joints are distinctly longer than wide.

Syzygia on the fourth and eighth or ninth brachials; then an interval of 2–5 joints between successive syzygia.

The first six pinnules have wide basal joints, the fourth and

two following ones being more or less expanded towards the dorsal side. This is most marked in the lowest pinnules of the larger specimen. The later pinnule-joints are elongated, but very much more slender in the small specimen than in the larger one. The lower pinnules appear to be the longer, containing more numerous, though shorter joints. That on the fourth brachial in the larger specimen is almost 12 mm. long, and consists of twenty-five joints.

Disk 5 mm. wide. It bears numerous calcareous nodules, but the brachial ambulacra only have delicate rods and networks of limestone at their sides. Sacculi are present, though small, inconspicuous, and few in number. Skeleton white.

The smaller specimen is $3\frac{1}{5}$ mm., and the larger $4\frac{1}{2}$ mm. across the centrodorsal.

H.M.S. 'Challenger.' 1874. Station 205. Lat. 16° 42′ N.; Long. 119° 22′ E. Depth 1050 fms. Grey ooze.

This is a very singular species. The two mutilated individuals described above resemble one another very closely in the characters of the calyx and arms, while the cirri and pinnules vary considerably. In the smaller one I can find no certain trace of any but the long-jointed cirri like those of *E. Semperi* and *E. japonicus*. But in the larger form, which retains the bases of two, if not more, of these, the majority of the cirri consist of numerous short joints but little longer than wide.

In the smaller form, again, most of the pinnules are quite slender and delicate, with somewhat glassy joints which are twice, or more than twice, as long as wide. But in the larger one they are usually considerably stouter and more massive, though one or two of the lowest pinnules are much more slender than their fellows, and somewhat resemble those of the smaller individual. The variation in these pinnule characters and the striking dimorphism of the cirri are the more remarkable, as in most *Comatulæ* the peculiarities of these organs are of considerable value in the distinction of species.

3. Eudiocrinus Semperi, n. sp.

Centrodorsal small, nearly hemispherical, or somewhat flattened, thickly covered with cirrus-sockets except at the dorsal pole. These have strongly marked articular rims around the opening of the central canal, and are from twenty to thirty in number. Cirri probably 30 mm. long and tapering, of 21+

joints; the first three quite short, the fourth more than twice as long as wide, and the next four the longest, sometimes exceeding 2 mm. The following ones diminish slowly in size, but exhibit no traces of any dorsal spines.

Radials partially visible. First brachials nearly oblong, widening slightly, and then narrowing a little. Second brachials quadrate, and appearing in a side view of the specimen to project strongly backwards into the first brachials, as the surfaces of both joints rise towards the middle of their line of junction. The following joints have unequal sides, the fourth having a syzygy and bearing a pinnule on the shorter side. In one specimen the pinnule is on the right side in all but the right anterior ray; and in the other in all but the two antero-lateral rays. The seventh joint is more oblong; and the eighth and following joints become more distinctly unequal-sided, the breadth being somewhat less than the length of the longer side which bears the pinnule. Further out on the arms the length gradually increases in proportion to the breadth, and the joints become more and more cylindrical.

The second syzygy is on the seventh, eighth, or ninth brachial; and the later syzygial intervals vary from one to four joints.

The lower pinnules are all about equal in length, and consist of some twenty joints. Except in the first four or five pinnules all but the lowest joints are twice as long as broad, or slightly longer, and more transparent and glassy than the cirrus-joints. Ovaries short, not extending over more than three or four joints. Towards the arm-ends the pinnules gradually decrease in length and in number of joints.

Mouth central. Disk and arm-bases rather closely plated, but the brachial ambulacra merely have irregular rods and networks of limestone at their sides. They lie close down between the muscles and show no traces of sacculi. Skeleton white.

Disk 5 mm. in diameter. Radial pentagon 4 mm. Spread probably about 15 cm.

H.M.S. 'Challenger,' 1874. Station 164. Lat. 34° 8′ S.; Long. 152° 0′ E. Depth 950 fms. Grey ooze. One specimen.

Station 169. Lat. 37° 34′ S.; Long. 179° 22′ E. Depth 700 fms. Grey ooze. Two specimens.

I have named this species after Prof. Semper of Würzburg, to whom we owe the discovery during his residence in the Philippine Islands of the type species of *Eudiocrinus* (*E. indivisus*).

The absence of pinnules on the second and third brachials distinguishes it from this last and also from *E. varians*. Although *E. indivisus* is richly provided with large sacculi at the sides of the brachial ambulacra, they are smaller and more scanty in *E. varians* than in *Atelecrinus* or in any *Antedon* I know; while they are absent altogether in *E. Semperi* and in the closely allied *E. japonicus*. These organs occur in all the other genera of *Comatulæ* which have a central or a subcentral mouth, viz. *Atelecrinus, Antedon*, and *Promachocrinus*; while they are also found in nearly all the genera of Stalked Crinoids which have the mouth in this position, viz. *Rhizocrinus, Pentacrinus*, and *Bathycrinus*. I have no information as to their presence or absence in *Ilycrinus*, but I have failed to find them in *Holopus*.

Eudiocrinus Semperi, like other *Comatulæ*, exhibits a certain amount of local variation. All three specimens were obtained in a very mutilated condition, hardly any thing remaining of one of them but the calyx and the bases of three arms. But sufficient remains of the other two to indicate a considerable amount of flexibility in some of their characters. That from the lesser depth (Station 169) is the larger of the two, and its disk bears larger and more numerous plates; while there are fewer cirri on the centrodorsal, and the pinnule-joints are somewhat shorter and less glassy than those of the individual from Station 164. In the former also, both the antero-lateral rays have the first pinnule on the left side; while in the latter this is only the case in the right anterior ray.

4. Eudiocrinus japonicus, n. sp.

Centrodorsal relatively large, conical, and covered except at the dorsal pole by 40–50 cirrus-sockets, with a well-marked articular rim around the opening of the central canal. Cirri more than 35 mm. long, tapering, and consisting of 27+ joints; the first three are quite short, the fourth a good deal longer than wide, and the next four the longest, but scarcely reaching 2 mm.; the following ones diminish slowly in size, but exhibit no traces of any dorsal spine.

Radials just visible. First brachials trapezoidal, the proximal edge being wider than the distal one, where the union with the second brachial is by a ligamentous articulation. The proximal faces are produced into large muscle-plates for articulation with the radials. The second brachials, as seen from below, are also trapezoidal, being narrower along their proximal edges. The

surfaces of both joints rise towards the middle line of their junction, so that in a side view of the specimen the second seem to have strong backward projections into the first brachials. The next four or five joints have unequal sides, the fourth being a syzygy and bearing a pinnule on its shorter side. In the only specimen with all the arm-bases preserved, one of them has the first pinnule on the left side. The fifth and one or two following joints also have the pinnule on the shorter side. The next is more oblong, and its successor again a syzygy, with the pinnule on its longer side. The succeeding joints have still more markedly unequal sides, the breadth being about equal to the length of the longer side. After the second syzygy there is an interval of four or five joints between successive syzygia.

The lowest pinnules are apparently tolerably equal, consisting of some twenty stout joints, of which only a few middle ones are longer than wide. Beyond the eighth brachial, the pinnule-joints become relatively longer and thinner and the pinnules more slender. Ovaries short, not extending over more than three or four joints.

Mouth central or subcentral. Disk naked, 7 mm. in diameter. Brachial ambulacra close down between the muscles, with a few supporting rods and networks of limestone, but no traces of sacculi. Skeleton white.

Diameter of radial pentagon $4\frac{1}{2}$ mm.

H.M.S. 'Challenger,' 1874. Station 235. Lat. 34° 7′ N.; Long. 138° 0′ E. Depth 565 fms. Mud. Three much mutilated specimens.

It is with some hesitation that I have separated this species from the preceding one. It is altogether larger and more massive than *E. Semperi*, with a larger and more distinctly conical centrodorsal and more numerous cirri. The first brachials have larger muscle-plates for articulation with the radials and are more trapezoidal in outline, so that the arm-base is distinctly narrowed at the junction of its first two joints. The fourth and next following joints are relatively shorter and more oblong than in *E. Semperi*, though the general proportions of the remaining arm-joints seem much the same in the two cases. The position of the first pinnule, *i. e.* whether on the right or left side of the arm, does not appear to be a character of much importance, as the two examples of *E. Semperi* do not agree in this respect. One of them has the first pinnule on the left side in two arms, but the other only in one, as in the solitary specimen of *E. japonicus* which has the arm-bases at all well preserved.

There are some specimens of *Eudiocrinus* in the University Museum at Berlin, which were kindly shown to me by Dr. Hilgendorf, who had collected them in Japan. I think that they are probably identical with the type just described. They have rather fewer cirrus-joints, and the junctions of the first eight brachials are distinctly tubercular. The tubercle between the first pair is in the middle line, and those between the following joints lie alternately on either side of the arm. The three 'Challenger' examples, however, show no traces of these tubercles, with the exception of the median one, which is far less marked than in the Berlin specimens.

II. The Comatulæ of the Hamburg Museum.

When I visited my friend Dr. H. Ludwig (now professor at Giessen) at Bremen in August 1880, I found that the Echinoderm collection of the Hamburg Museum was in his hands for the purpose of description. It included several fine *Comatulæ*, to examine which I was then on my way to Hamburg; and Dr. Ludwig most kindly offered to ask permission from the directorate of the museum to transfer them to me for examination and description. This was readily granted by Dr. H. Bolau, the chief director, and by Dr. Karl Kraepelin, who has especial charge of the Echinoderms, and was good enough to forward to me four dry specimens that had not been sent to Dr. Ludwig. To all these gentlemen, therefore, my sincere thanks are due for their courteous readiness to facilitate my work.

Apart from the ordinary European *Comatulæ*, the museum contains nine species of *Antedon* and seven of *Actinometra*. Eight species of the former genus and one of the latter are new to science, while *Act. robusta*, Lütk., though long known in collections, is here described for the first time; and the occurrence of a well-preserved spirit-specimen of *Act. solaris*, Müll., has enabled me to add somewhat to our knowledge of this important type.

The mutual relations of the various species referred to in the following pages are shown in the accompanying keys.

Genus Antedon, *de Frem.*

A. Ten arms.
- *a.* Arm-joints compressed and keeled .... 1. *carinata*, Lam.
- *b.* Arms not keeled. Lower pinnules smooth-jointed and tolerably equal .... 2. *lævipinna*.

B. Rays divide three times; each division of two joints, the axillary without a syzygy.
  a. The fourth and fifth brachials bear large tolerably equal pinnules .... 3. *æquipinna.*
  b. Pinnule on fourth brachial much larger than those on the fifth and sixth...... 4. *imparipinna.*
C. Rays divide three times. First division of three joints, the axillary with a syzygy; second of two joints, the axillary without a syzygy.
  a. About thirty cirrus-joints. Lower pinnules unlike on inner and outer arms of each ray.
    1. Bases of the rays almost smooth. Middle and outer parts of the arms serrate........................ 5. *variipinna.*
    2. First radials crenulate. Rays tubercular at the base. Middle and outer parts of the arms smooth .... 6. *crenulata.*
  b. Fifty or more cirrus-joints. Lower pinnules similar on all the arms.
    1. Terminal cirrus-joints smooth........ 7. *acuticirra.*
    2. Terminal cirrus-joints have dorsal tubercles........................ 8. *Ludovici.*
D. Rays divide three times; each division of three joints, the axillary with a syzygy.
  a. Cirri long and stout, with imperfect claw and smooth terminal joints .... 9. *bipartipinna.*

1. ANTEDON CARINATA, *Lam.*, sp.*

The museum contains eight examples of this species, including two dry ones from Mauritius, the original home of the type. They are remarkable for the very slight carination of the dorsal surface of the arms. Had Lamarck's original specimens been like these, he would assuredly never have given them the specific name "*carinata.*"

There are also two examples (*sine patria*) which have as many as thirty cirri, a larger number than is found on Mauritius specimens; while the pinnules are considerably stouter and more fleshy than in the type, the lower ones especially having broader basal joints.

The remaining four specimens of this widely distributed species are from Java, a new locality for it. They are more like the Mauritius type, having only from twenty to twenty-five cirri and more slender pinnules; but the later pinnules are much less stiff than usual, so that the arm-ends have a more feathery appearance than is the case in the type.

2. ANTEDON LÆVIPINNA, n. sp.

Description of an Individual.—Centrodorsal a thick convex disk,

* The literature of this species will be found on pp. 179, 180 of 'Notes from the Leyden Museum,' vol. iii.

bearing seventeen marginal cirri. These consist of 25–35 thick joints, the first five or six of which are short and broad, and their immediate successors about square. A faint dorsal spine appears about the tenth joint and increases in size rather rapidly, the joints also shortening somewhat. In the later joints the spine is slightly smaller and projects forwards rather less strongly, but it is larger on the penultimate than on any previous joint.

Ten arms, the rays dividing only once, but remaining close to one another. Three radials visible. The first are longer at the sides than in the centre, and the second broadly hexagonal, partly united laterally. Both they and the axillaries rise towards the middle of their line of junction, which stands up as a prominent tubercle. Axillaries almost triangular and but little longer than the second radials. First brachials widely pentagonal, partly united by their inner ends, which are somewhat shorter than the outer ones. Second brachials irregularly quadrate, their inner ends projecting beyond the edges of the preceding joints. The outer sides of both joints are somewhat flattened laterally, and they rise steeply towards their line of junction just as the two outer radials do. Third brachial short and oblong, a syzygy. The next few joints also short, rounded and nearly oblong, with slight backward projections alternately from the inner and outer sides of their proximal edges. The following ones short and sharply wedge-shaped; at first considerably wider than long, but narrowing rather quickly and also commencing to overlap, so that the middle and later joints are almost saucer-shaped.

Syzygia on the third and eighth brachials; then an interval of 6–12, usually 9 or 10, joints between successive syzygia.

None of the pinnules are specially distinguished. The first, on the second brachial, is slender, consisting of about fifteen smooth cylindrical joints. The next (on third brachial) is shorter and more slender; and the next about as long as the first, but stouter, having thicker joints all very smooth. The basal joints of the next two pairs are still rather thick, after which they decrease in size; and the pinnules increase very slowly in length, never becoming specially long, and consisting of smooth cylindrical joints. Disk about 6 mm. in diameter, almost concealed; anal tube plated.

Colour light brown, with purplish bands. Sacculi closely set on the pinnule-ambulacra. Spread 15 centim.

One specimen from Canton.

Remarks.—The tubercular character of the radials and the

equality in length of the smooth lower pinnules on the outside of the arm distinguish this species from any hitherto described.

3. ANTEDON ÆQUIPINNA, n. sp.

Description of an Individual.—Centrodorsal discoidal, bearing about forty cirri in a single or partially double marginal row, which leaves the flat dorsal surface free. Cirri of 24–28 tolerably uniform, smooth, thick joints, of which the sixth is about square, while those immediately following it may be a trifle longer than broad; the penultimate has a small blunt spine, a trace of which is sometimes visible on the preceding joint.

First radials not visible; second short and wide, nearly oblong, slightly united laterally. Axillaries less than twice their length, pentagonal, with wide distal angles.

43 arms of 160 smooth joints, the rays dividing three or rarely four times. Each division of two joints, the first closely united to their fellows and the axillary not a syzygy. First brachials almost rhomboidal, relatively long and narrow and closely united to their fellows. Second joints much shorter and nearly oblong, slightly longer on the outer than on the inner side. Third (a syzygy) and the next four joints transversely oblong, with traces of forward and backward projections alternately on opposite sides. The following ones longer, though still short and sharply wedge-shaped, considerably wider than long; becoming blunter towards the middle of the arms and squarer towards the ends.

First syzygy on the third brachial, and the next between 9 and 20, usually about 16; after which the syzygial interval is 6–12, usually 8 or 9, joints.

First pair of pinnules, on second and third brachials, short, slender, and tolerably equal, of about 20 longish joints. The next pair twice their length (13 mm.), much stouter, and rather stiff. The next pinnule (on 6th brachial) somewhat smaller than the first one, and the next four continue to decrease. The remaining pinnules gradually increase in length, becoming slender and delicate in the outer parts of the arms, but not longer than the second pair.

Disk naked and somewhat incised, 20 mm. in diameter, and coloured dark grey. Skeleton an alternation of purplish red and white, with alternating double rows of dark spots on the white parts.

Brachial ambulacra close down between the muscles; those of the pinnules more fleshy, with closely set sacculi.

One specimen *sine patria*. Spread about 20 centim.

Remarks.—This species comes very near to *Ant. lævicirra* of the Leyden Museum. It differs, however, in having more numerous cirri, the second radials less closely united, and shorter axillaries. The lower and middle arm-joints are relatively shorter, and the two pinnules of the second pair (on 4 and 5 brachials) are more nearly equal than in *A. lævicirra*; while the terminal pinnules are much more delicate and less clothed with perisome.

The colouring is not unlike that of *Ant. bimaculata*, also in the Leyden collection; but in this species the third pinnule on the outside of the arm (on 6th br.) is larger than the second, while the reverse is the case in *Ant. æquipinna*.

4. Antedon imparipinna, n. sp.

Description of an Individual.—Centrodorsal a convex disk with a slightly hollowed dorsal pole and two or three rows of cirri on its sloping sides. 35 cirri of 25–28 smooth thick joints, of which the sixth is about square and the following ones longer than broad, becoming shorter again towards the end; the penultimate bears a very faint blunt spine.

First radials partially visible at some of the angles of the calyx; the second, widely hexagonal, partly united laterally. Axillaries not one and a half times their length, pentagonal, with wide distal angles. The lines of junction of the axillaries with the joints above and below them are narrower than the joints themselves, so as to give the sides of the rays a somewhat jagged appearance.

38 arms, the rays dividing thrice; each division of two joints, the first almost completely united laterally and the axillary not a syzygy. First brachials almost rhomboidal, relatively long and narrow, closely united to their fellows. Second joints shorter and more wedge-shaped, longer on the outer than on the inner side. Third joint a syzygy and oblong. The next four nearly so, but shorter. The following ones longer, though still short, smooth, and sharply wedge-shaped, considerably wider than long. About the middle of the arm they become blunter, with forward projections alternately on opposite sides, and are squarer towards the ends.

The first syzygy is on the third brachial, and the next usually from 12–14, after which the syzygial interval is from 8–10 joints.

The second brachial bears a moderately long pinnule, tapering away rapidly after the basal joints, which are relatively rather large. That on the third brachial is considerably smaller, but

the next one (on 4th br.) is unusually large and massive, consisting of 30 stout joints and reaching 15 mm. in length. The next two are smaller again and about equal to the first pinnule; the following pair still smaller, after which the length gradually increases, though it never much exceeds that of the first pinnule.

Disk invisible; diameter across the circle of distichal axillaries 13 mm. Colour brownish white, with traces of darker spots. Sacculi rather scanty on the pinnule-ambulacra. Spread probably about 15 centim.

One specimen *sine patria*.

Remarks.—This species is distinguished from the previous one by the great disproportion in the sizes of the third and fourth pinnules. It is much more marked than in *Ant. lævicirra*, which also differs in having more uniform cirrus-joints, a longer interval between the first two syzygia, and less marked forward projections on the arm-joints.

5. ANTEDON VARIIPINNA, n. sp.

Description of an Individual.—Centrodorsal a moderately thick convex disk, bearing about 25 cirri in a double row. These have about 30 tolerably uniform joints, of which the fifth is about square, the next two or three a trifle longer than wide, and the following ones shorter again. From about the twelfth onwards the joints have rather sharp dorsal spines, that on the penultimate being considerably larger than its predecessors. First radials partially visible; the second oblong, short and wide, partly united laterally. Axillaries also short, but little longer than the preceding joints, and pentagonal with very open angles.

23 arms, some rays dividing thrice; primary arms of three joints with somewhat uneven edges, the last being axillary with a syzygy. Secondary arms of two joints, the axillary not a syzygy. The first joints after each division rhomboidal and closely united laterally. Second brachial bluntly wedge-shaped. Third (syzygy) and four next joints short and oblong. The following ones short, bluntly wedge-shaped, and overlapping rather strongly, so as to give the arms a serrate appearance; becoming more oblong again about the middle of the arm.

First syzygy on third brachial; the next between 19 and 25, then an interval of 7–12 joints, usually 9 or 10, between successive syzygia.

The size of the lower pinnules varies considerably according as

they are on the outer or inner arms of the rays. The first pinnule, which is borne by the second distichal, is moderately long and stout at the base, but tapers rather rapidly. The pinnules on the second joints of the outer arms are both longer and stouter than the distichal pinnule, sometimes very much so; while that on the fourth brachial is equal to or slightly larger than it. The pinnules on the third and fifth joints are both smaller than their fellows on the outside of the arm, and the size decreases to the fourth pair, after which it gradually increases again. On the inner arms of the rays the fourth brachial usually bears the largest pinnule, those on the second and sixth joints being about equal. The distal ends of the cylindrical joints of the large lower pinnules are raised into slight spines.

Disk naked and considerably incised, 10 mm. in diameter.

Colour purple, with whitish bands; sacculi closely set along the pinnule-ambulacra.

Spread probably about 10 centim.

One mutilated specimen from Canton.

Remarks.—The characters of the lower pinnules distinguish this species very readily from other *Antedons* with primary arms of three joints, the axillary with a syzygy, and secondary arms of two joints, the axillary without a syzygy. This section of the genus includes *A. Savignyii* of the Red Sea, and about fifteen other species, four of which are in the Hamburg Museum.

6. ANTEDON CRENULATA, n. sp.

Description of an Individual.—Centrodorsal a thick convex disk 5 mm. in diameter, with a single or partially double row of about 20 marginal cirri. These have 30+ joints, of which the sixth is longer than broad and the following ones tolerably equal; the eleventh joint and its successors bear strong, forward projecting dorsal spines, which diminish again after about the 25th joint.

First radials partly visible, with crenulated distal edges; the second trapezoidal, closely united laterally, and rising rather sharply towards the middle of their junction with the pentagonal axillaries, which are about twice their length. Rays very close to one another and divide twice, or sometimes three times. The first division of three joints, the axillary with a syzygy; and the second of two joints, the axillary without a syzygy. The first two joints beyond each axillary form a slight tubercular elevation at the middle line of their junction. First brachials rhomboidal

and closely united laterally; the second longer and sharply wedge-shaped. Third (syzygy) and five or six following joints short and oblong. The next ones triangular, more than twice as wide as long and overlapping; gradually becoming smoother and more oblong in the middle and outer parts of the arms.

First syzygy on third brachial; the next on 12 or 13, then an interval of 7–10 joints between successive syzygia.

Pinnules variable. The distichal pinnule seems to have been less stout than that on the second brachial. The third brachial bears a small pinnule, usually less than half the length of that on the fifth joint. On the outer arms of the rays the fourth, fifth, and sixth joints bear large pinnules like that on the second; sometimes the fourth, and sometimes the sixth, bears the larger one. The next pair, on the seventh and eighth joints, are smaller again. On the inner arms the fourth joint, like the third, bears a small pinnule; and the next two pairs are large, the second pair (on 7th & 8th br.) being the larger. Sometimes, however, the only two really large pinnules are those of the sixth and seventh joints, the previous pair being smaller, but not specially so, like the pinnule on the third joint. These long lower pinnules consist of about 25 stout joints, the distal ends of which have forward projecting lateral processes. In the large lower joints these are chiefly limited to the outer side, but they appear on both sides in the later joints. Similar, but less marked, processes are visible on the cylindrical joints of the remaining pinnules, which increase again in size after the fifth pair, but never become as long as the large lower pinnules.

The colour of the skeleton seems to have been white, and the perisome purplish.

One broken specimen from the neighbourhood of Borneo.

Remarks.—The foregoing description is based upon some dried fragments of a moderately large *Antedon* which appears to be new. Besides the three other species belonging to the *Savignyii* group which are described in this communication, I am acquainted with about a dozen more, nearly all of them from the Eastern Seas. But I have been unable to identify any of them with the form under consideration, which is peculiar in the crenulation of its first radials, the shortness of its arm-joints, and the form of the spines on the cirri and pinnules. It is altogether a larger species than *Ant. variipinna*, from which it is readily distinguished by its crenulated first radials, tubercular arm-bases, and smoother

arms, while the inequality in the sizes of the lower pinnules is not of the same character in the two species.

7. ANTEDON ACUTICIRRA, n. sp.

Description of an Individual.—Centrodorsal a thick disk with a flat dorsal surface and 15 long tapering cirri in a single marginal row. These may reach 5 centim. in length and consist of 55 smooth joints. The basal ones are broad and the tenth about square, while the following ones diminish in width and thickness, though the length changes but little. The later ones are longer than wide, but not laterally compressed, the cirri tapering gradually to a sharp point. Terminal claw small and but slightly curved, without any trace of an opposing spine.

Calyx variable; some of the first radials are partially visible, and some of the short second radials are partly concealed. These are closely united laterally; the axillaries nearly twice their length, almost triangular, with open distal angles.

26 long and tapering arms of 200+ joints. Some of the rays divide three times. First division of three joints, the axillary with a syzygy; and the second usually of two joints, the axillary not a syzygy. First joints after each axillary closely united laterally, and slightly raised in the middle line of their junction with their successors. First brachials rhomboidal, short, and wide; the second more wedge-shaped. Third (syzygy) and next four or five joints short and oblong; the following ones bluntly wedge-shaped, twice as wide as their longer side, and slightly overlapping; the middle and later joints more oblong and overlapping rather less.

First syzygy on the third brachial, and the next from 9–16; after which the syzygial interval varies from 5–32, usually from 10–15 joints.

The first pinnule, borne by the second distichal, is comparatively small, with keeled and expanded basal joints. That on the second brachial is considerably larger on the outer arms, but remains small on the inner ones; while those of the fourth and sixth brachials increase in size, the latter reaching 25 mm. in length, and consisting of nearly 40 joints. On the inner side of the arm the third brachial bears a small pinnule like the second distichal, and the next two are much larger, the second one approaching the size of its fellow on the preceding (sixth) joint. The following one (on 8th br.) is somewhat smaller again, though still long; and the next pair are a good deal shorter than their

immediate predecessors, though somewhat larger and stouter than that on the second brachial. Where no distichals are present, but the radial axillaries bear arms directly, the fourth pair of pinnules are large like their immediate predecessors. The size decreases to about the fifteenth joint, and then increases very slowly again, the outer pinnules only reaching about one third the length of the largest lower pinnules, which have wide and strongly keeled basal joints. On the smaller pinnules after the fifth pair this carination is less marked, but it is traceable for some little way out on to the arms.

Disk naked and considerably incised, 15 mm. in diameter.

Colour nearly white, with traces of a deep violet remaining. Sacculi very close along the pinnule-ambulacra.

Spread about 25 centim. One specimen *sine patria*.

Remarks.—This fine species differs from all but two of those in the *Savignyii* group in the great length of its cirri, which are only exceeded by those of *Ant. Eschrichtii*, *Ant. phalangium*, &c.; and, despite their length, they are remarkable for being in a comparatively undeveloped condition. The terminal claw is very small and but slightly curved, without any trace of an opposing spine, which is just the condition of the immature cirri of other species.

There is an *Antedon* from Sydney in the University Museum at Copenhagen, bearing the MS. name of *Ant. australis*, Lütk., which has some resemblance to *Ant. acuticirra*. With the same arrangement of the ray-divisions, it has a few long and many-jointed cirri and a large third pair of pinnules; but it has relatively shorter axillaries and a shorter syzygial interval, usually 6–8 joints instead of 10–15. Without a more detailed examination of the Copenhagen specimen than I have as yet been able to make, it is difficult to be certain as to its identity with the one which I have described above as *Ant. acuticirra*.

8. Antedon Ludovici, n. sp.

Description of an Individual.—Centrodorsal a thick disk with a flattened dorsal surface and a single or partially double row of 25 marginal cirri. These have from 40–50 tolerably equal joints, all of which, except those at the extreme end, are wider than long. Even in these terminal ones the length is but little greater than the width, and there is a slight tubercle in the middle of the dorsal surface, which is most marked on the penultimate joint.

First radials partially visible; the second short, widely oblong, almost completely united laterally, and slightly raised in the

middle of their junction with the axillaries. These are one and a half times as long as the preceding joints, widely pentagonal, with open distal angles, and also slightly raised in the middle of the hinder edge.

30 arms, each of 150+ joints. The rays may divide three times: the first division of three joints, the axillary with a syzygy; and the second of two joints, the axillary without a syzygy. The first joints after each axillary rhomboidal and closely united laterally, with the distal edge very slightly incised to receive the convex hinder edge of the next joint. Third brachial a syzygy, short and oblong. The next four or five joints also short, with somewhat oblique terminal faces, and slight backward projections alternately on the inner and outer sides. The fourth and sixth joints are thus longer on their inner sides, and the fifth and seventh on their outer ones. Following joints shor bluntly wedge-shaped and overlapping, nearly twice as wide as long, and becoming more oblong about the middle of the arm.

First syzygy on the third brachial; the next from 8–16, usually on 12; then an interval of 7–14, usually 9 or 10, joints between successive syzygia.

First pinnule on the second distichal, quite small, little more than half as long as and far more slender than those on the second and third brachials, which are about equal. The next pair are still larger, and the third pair (on 6th & 7th br.) still more so, consisting of about 35 stout joints and reaching nearly 35 mm. in length. That on the seventh joint is rather the smaller and the next pair considerably so, only about equal to the first pair. The diminution continues to about the seventh pair, which are not specially small, being scarcely less than 10 mm. long. The remaining pinnules are of about the same length, but gradually become more slender. The basal joints of the lower pinnules from the distichal pinnule onwards have rather sharp dorsal keels. These may be less marked on the stout joints of the pinnules of the second and third pairs, but reappear on the second and four following joints in the fourth pair, and then gradually decrease in distinctness, disappearing altogether by about the 25th joint.

Disk naked and considerably incised, 15 mm. in diameter.

Colour light brown. Sacculi closely set along the pinnule-ambulacra. Spread 20 centim.

One specimen from Hong Kong.

Remarks.—I have named this fine species after my friend Prof.

H. Ludwig, of Giessen, who is so well known by his important researches in Echinoderm morphology. Like *Antedon acuticirra* it has a large number of cirrus-joints, but they are relatively shorter and wider, so that the cirri do not reach more than 3 centim. in length, and taper less than the longer cirri of that species do; while the later ones develop dorsal tubercles, which are altogether wanting in the longer terminal joints of *Ant. acuticirra*. The form of the cirrus-joints distinguishes *Ant. Ludovici* from the *Ant. australis*, Lütk., already referred to, which it resembles in the syzygial intervals and in the relative sizes of the third and fourth pairs of pinnules, though the lower joints of the latter are less strongly keeled in the Copenhagen specimen than in *Ant. Ludovici*. The single specimen of this last species in the Hamburg Museum has two or three of the pinnules very much enlarged and unnaturally overgrown. In one case the malformation is connected with the development of a large cyst on the ventral perisome of the arm, which is protected by a coating of polygonal plates, and is most probably the home of a parasitic *Myzostoma*.

9. Antedon bipartipinna, n. sp.

Description of an Individual.—Centrodorsal a thick, slightly convex disk, bearing a single marginal row of 14 long and stout cirri. These may reach almost 6 centim. in length, and consist of nearly 60 joints. The basal joints are very wide, nearly 2 mm. the 15th and following ones about square, and the terminal joints slightly longer than wide, quite smooth, with a very imperfectly formed claw and no trace of an opposing spine.

First radials partially visible at the angles of the calyx; the second shorter in the middle line than at their sides, where they are closely united to their fellows. Both they and the short, almost triangular axillaries rise to a slight tubercular elevation in the middle line of their junction.

35 arms of 200+ joints. The rays in close contact, but dividing three times. First division of three joints, the axillary with a syzygy; the second usually the same, but sometimes of two joints, the axillary without a syzygy. The first joints after each axillary are rhomboidal and closely united laterally, and the second more wedge-shaped, the middle of their junction being tubercular like that of the two outer radials. Third brachial (syzygy) and the next four or five joints oblong; the following ones short, sharply wedge-shaped and very slightly overlapping, twice as wide as long.

About the middle of the arm they become more equal-sided, and are nearly oblong in the terminal portions.

First syzygium on the third brachial, and the next from 11–15; then an interval of 6–12, usually 8 or 9, joints between successive syzygia.

First pinnule on the second distichal, quite short; but the next three on the outside of the arm (on 2nd palm., 2nd & 4th br.) are rather longer. They all have somewhat the appearance of being in two parts, as if they had been broken and regenerated. The lower half consists of wide and thick joints with dorsal keels; while the upper half is composed of quite small joints, and grows, as it were, out of the middle of the wide lower portion. This is least marked in the pinnule on the fourth brachial, which is nearly twice as long as that on the second joint, stouter, and more uniformly tapering. The next (on 6th br.) is still longer, reaching 25 mm., and consists of about 50 broad joints, the lower ones of which are keeled; the following one (on 8th br.) is nearly as long, but less stout. On the inner side of the arm the seventh joint bears a large pinnule like the preceding one. That on the fifth joint is much smaller, and that on the ninth variable, sometimes small and sometimes nearly as large as its fellow of the fourth pair. In some arms the fourth or eighth joint may bear the largest pinnule. Beyond the fourth pair the length decreases, rapidly at first, but afterwards more gradually till about the 20th joint, beyond which the pinnules are tolerably uniform in size, decreasing again towards the arm-ends. The carination of the basal joints of the lower pinnules dies away gradually, and is lost after the tenth pair.

Disk naked and much incised, 15 mm. in diameter. Colour deep purple, almost black. Sacculi closely set along the pinnule-ambulacra.

Spread nearly 25 centim.

One specimen from Hongkong.

Remarks.—This is one of the very few species of *Antedon* which have three joints in the secondary as well as in the primary arms. I know of but seven species belonging to this section of the genus, in three of which the rays divide a fourth or even a fifth time. Apart from this character, they are altogether different from the species under consideration, which comes nearest to *Antedon Philiberti*, Müll. sp., from Java. It differs, however, in the peculiar shape of the lowest pinnules, and in the undeveloped condition of the terminal cirrus-joints, none of which, even the penultimate, bear dorsal spines.

Genus ACTINOMETRA, *Müll.*

A. Second and third radials united by syzygy. Ten arms, very wide at the base.	
a. Lower joints of the pinnules on the third and some of the following brachials have expanded keels........	1. *solaris*, Lam.
b. Lower joints of second and third pairs of pinnules not keeled. Arm-bases tubercular......................	2. *robusta*, Lütk.
B. Second and third radials united by ligament. Rays divide from 2–5 times. The first division of three joints, the axillary with a syzygy.	
a. Only two ray-divisions	3. *parvicirra*, Müll.
b. Second division of two joints, the axillary with a syzygy. Third division like the first....................	4. *grandicalyx*.
c. Second and third divisions of two joints, the axillary with a syzygy ..	5. *multiradiata*, Linn.
d. Second division like the first. No further division	6. *Meyeri*, n. sp.
e. Second and subsequent divisions all like the first....................	7. *Bennetti*, Mus. Leyd.

1. ACTINOMETRA SOLARIS, *Lam.*, sp.*

Description of an Individual.—Centrodorsal a thin pentagonal disk, bearing two cirri at each angle. These have 22 or 23 joints, the fourth of which is about square; the remainder tolerably equal and longer than broad, the penultimate having a well-marked spine.

Three radials visible; the second trapezoidal, closely united laterally and widest along the distal edge, where they are united by syzygy to the triangular axillaries, which are more than twice their length.

Ten arms of 130+ joints, and only slightly increasing in width from the base. First two brachials joined by syzygy; the lowest one closely united to its fellow, shorter on the inner than on the outer side, which is only two thirds of the width. The next five or six joints more oblong, with their junctions slightly raised alternately on the inner and outer sides. Succeeding joints triangular, with convex proximal and concave distal edges, half as long as wide (nearly 5 mm.), and becoming more quadrate towards the arm-ends. The lower and middle parts of the arms have a faint, slightly raised, medio-dorsal line.

* The literature of this species will be found on p. 192 of 'Notes from the Leyden Museum,' vol. iii.

A syzygy in the third brachials*, and another about the eleventh joint; then an interval of 3–5 joints between successive syzygia.

The first pair of pinnules are borne by the epizygals of the two lowest syzygial joints. They are about equal in length (20 mm.), and consist of about 40 joints, the lowest five or six of which are wide and stout, with prominent dorsal edges but no distinct keels. The next two pinnules on either side are of decreasing length and stoutness, the second and third joints being wide, with strong and expanded dorsal keels. The fourth pair, though somewhat shorter than the third, are considerably stouter, with wider and more massive joints and large genital glands. The following ones somewhat longer and tolerably equal, decreasing again after about the 25th joint, but remaining stiff throughout and never becoming specially slender. The lower and middle joints of these pinnules, till far out on the arms, are very wide (reaching nearly 2 mm.), with sharpened dorsal edges. The middle joints of the pinnules do not become elongated till about the 80th arm-joint. Terminal comb limited to the first three pairs.

Disk naked, 15 mm. in diameter, with a radial mouth. Colour brownish white, with a broad reddish-brown band on either side of a narrow lighter one in the median line of each arm.

Spread about 30 centim.

One specimen from Hongkong.

Remarks.—The fine specimen described above is one of many variations on the type of *Comatula solaris*, Lam., one of the species for which the genus *Actinometra* was originally created by Müller. Lamarck's examples were obtained in the Australian seas during the voyage of Peron and Lesueur (1803); and they were subsequently examined by Müller, whose description of them is

* In this species and its allies the two outer radials and the two lower brachials are united by syzygy, so that the true third brachial appears to be the second. This joint itself is primitively double, consisting of the original third and fourth brachials, which are united by syzygy, the pinnule on the third joint remaining undeveloped. There are very few *Comatulæ* (e. g. *Actinometra multiradiata*) in which this is not the case; and it is therefore convenient to speak of the third brachial as a syzygial or double joint. But the rare syzygial union of the first two brachials, as in *Act. solaris*, is of a different morphological value altogether; and it is therefore better for the purposes of description to consider them as really two joints, rather than as forming a single compound one. In most *Comatulæ* they are united by a ligamentous articulation, which has often been wrongly spoken of as a syzygy.

quite one of the best of any that he wrote. The large specimen in the Vienna Museum, which was described by Müller as *Actinometra imperialis**, was eventually referred by him to Lamarck's type†. Both forms agree in their general characters, as I have been enabled to determine by personal examination of their fragmentary remains—a privilege for which I am much indebted to Dr. Steindachner and Prof. Perrier. The peculiar features of the species are the characters of the lower pinnules. The first pair are composed of numerous stout joints, the lowest of which are stouter than, but not otherwise different from, their successors. But in the next pair of pinnules some of the lower joints have their dorsal edges produced into well-marked keels. In Lamarck's type these keels occur on the second, third, and fourth joints of the pinnules on the third and fourth brachials; while in the Vienna specimen there is little or no keel on the fourth joint of the fourth pinnule, and in the Hamburg one described above the third pair of pinnules have keels on their second and third joints. I do not, however, regard this variation as of any importance, though I think that the entire absence of any keel on the two lowest pinnules is a good distinctive character of the type. Other points in which the Paris, Vienna, and Hamburg specimens all agree are the unusual size of the lower arm-joints, which may be as much as 5 mm. wide, and also the shape of the joints composing the pinnules of the sixth and following pairs. These are best seen when the pinnules are dried, as they are then less concealed by perisome. The lowest joints are more than twice as wide as long; and though this disproportion gradually decreases, it is only quite at the extreme end of the pinnule that the joints become any thing like square. This peculiarity is, of course, most marked in the lower pinnules; but it is not until well on into the second third of the arm that the middle joints of the pinnules begin to be at all longer than broad.

What therefore may be called the special marks of *Act. solaris* are as follows:—10–15 cirri of 20–24 joints; arm- and pinnule-joints very wide; expanded keels on the lower joints of the second pair and some of the following pinnules, but the basal joints of the first pair are not keeled.

Closely related to this large type are several others of smaller size, and with fewer joints in the cirri, for which it is difficult as

* Wiegmann's Archiv, 1841, i. p. 141.

† Abhandl. d. Berlin. Akad. 1849, p. 248.

yet to determine the range of variation. Such are the specimens brought by Professor Semper from Bohol, and formerly referred to by myself as *Act. solaris* *. These have keels on the basal joints of the pinnules borne by the *second* and following brachials, and much less massive arm- and pinnule-joints. The *Asterias pectinata*, Linn.†, has traces of keels on the basal joints of both the first pinnules, while those of the next pair are strongly keeled. In a couple of small specimens from the voyage of Peron and Lesueur, which I found in the Paris Museum, the pinnules on the second and fourth brachials have keeled lower joints, but there is hardly any trace of this in the third pinnule; while in *Actinometra affinis*, Lütk. MS., from Java (Copenhagen Museum), the first three pinnules have strong keels, and there are lesser ones on the next pair. The Müllerian types *Comatula purpurea*, *C. brachiolata*, and *C. rosea* all belong to this "*solaris* group." In the first named, only the third pinnule has any keeled joints. The other two species were regarded by Müller as possibly identical, a view in which I entirely concur. In this type, which will therefore have to be known as *Actinometra rosea*, the basal joints of the first six pinnules are not specially marked, while the arm-bases have tubercles at the junction of the joints, alternately on the inner and outer sides.

It will be a matter of no little difficulty to determine the exact mutual relations of these various forms, which all agree with *Act. solaris* in the syzygial union of the two outer radials. The greater part of them are unfortunately dry and in a very fragmentary condition, as are Müller's original specimens of *Act. solaris*, on which account I have thought it desirable to redescribe the type from the fine spirit-specimen in the Hamburg Museum.

2. Actinometra robusta, *Lütken, MS.*

Centrodorsal a low flattened disk 7 mm. wide, bearing a single or partially double row of 20–25 marginal cirri. These have about 23 joints, of which the first three or four are wider than long, and the following ones about square, or a trifle longer than wide, decreasing slightly towards the end; the penultimate has a small opposing spine.

Three radials visible; the second short, trapezoidal, closely united laterally, and united by syzygy at their wider distal edges to the triangular axillaries, which are twice their length.

* Trans. Linn. Soc., 2nd ser., Zool. vol. ii. pp. 62 *seq.*

† 'Systema Naturæ,' ed. x. tom. ii. p. 663.

Ten arms of 200 joints, rather more than 3 mm. wide at the third brachial, but increasing to 5 mm. by the twelfth joint, remaining uniform to a short distance, and then tapering to the ends.

First two brachials united by syzygy, and together twice as wide as their outer side, which is slightly the longer, though the hypozygal (on 1st br.) is longer at its inner side, which is very closely united to its fellow. Epizygal (on 2nd br.) acutely triangular, with curved sides, half as long as broad. Third brachial a syzygy, roughly oblong, with a somewhat raised forward projection from the inner part of its distal edge; and the fourth brachial has a corresponding elevation at the inner side of its proximal edge, so as to give a somewhat tubercular appearance to the line of junction. The same feature is visible on the outer part of the line of junction between the nearly oblong fourth and fifth brachials, and recurs alternately on opposite sides of the arm for a few joints further. As the joints become flatter and more triangular, with curved edges, it gradually disappears. They are rather more than half as long as wide, with a very faint, slightly raised median line, and retain the triangular shape and curved edges as far as the 160th joint, narrowing and becoming blunter at the extreme ends of the arms.

Syzygia on the third and tenth brachials; then an interval of 3–6, usually 4 or 5, joints between successive syzygia, the hypozygals being very short.

The first pair of pinnules borne on the epizygals of the two lowest syzygial joints are long (25 mm.), and moderately stout, consisting of about 60 joints, of which the first three or four are nearly square. The following ones are shorter and more oblong, and gradually decrease in width, the outer edges of the last 30 bearing the strong lancet-shaped processes forming the terminal comb. The second pair of pinnules are smaller with fewer joints, only the first two of which are about square, while they have no dorsal keels. They also have a well-marked terminal comb; but this appears to be wanting on the pinnules of the third pair, which are still smaller, with short and wide triangular basal joints. The fourth pair as long or longer than the third, but stouter, with wider and more massive joints. The following pinnules increase in both length and stoutness, consisting of about 30 joints, the first half of which are about twice as wide (2 mm.) as long, with sharpened dorsal edges which are sometimes pro-

duced into slight keels. The largest pinnules are those between the 10th and 25th brachials, and a little further on they become more slender, with squarer joints, the terminal pinnules having somewhat elongated joints.

Disk 25 mm. wide, without any trace of calcareous deposits. Colour of dry specimen black. Spread probably about 25 centim.

One specimen from Australia.

Remarks.—The above description is based upon a couple of dry specimens, one of which is in the Hamburg Museum, and the other now in the possession of Dr. Carpenter; they were both purchased originally from the Messrs. Godeffroy, for whom the type had been named by Dr. Chr. Lütken, of Copenhagen; but he has published no description of it, and informs me that he does not intend to do so, being now occupied with another branch of zoology. Specimens of the type, bearing his MS. name, occur in a good many museums; and I have therefore thought it undesirable to rename it.

Act. robusta has a considerable resemblance in general appearance to *Act. solaris*, both species having large arms composed of massive triangular joints with curved edges, and stout pinnules of broad joints. The arm-bases of *Act. solaris*, however, are nearly or quite smooth, and have little tendency to alternate tubercular elevations such as are visible in *Act. robusta*; in the latter species, too, the width of the arms increases more distinctly in the first few joints than in *Act. solaris*, while the second and third pairs of pinnules have no expanded keels on their lower joints such as appear in *Act. solaris*, and the cirri are larger and more numerous.

3. Actinometra parvicirra, *Müll.*, sp.*

Two specimens of a small *Actinometra* from Peru must, I think, be referred to this species. I can find no characters by which I can separate them from any one of its various forms that inhabit the Eastern seas. One of them is very small, and has lost its disk, but the other is larger and more perfect, though wanting some of its arms. The mouth is not quite so distinctly interradial as in the Philippine specimens, which I have described† as *Act. polymorpha*, but there is the same dimorphism of the arms. All are grooved, but the grooves on the posterior arms are much

* The literature of this species will be found on p. 204 of 'Notes from the Leyden Museum,' vol. iii.

† Trans. Linn. Soc. 2nd ser. Zool. vol. ii. pp. 29–53.

smaller and less distinct than on the anterior arms, and do not extend on to the pinnules. Some of these hinder arms consist of less than fifty joints, while in the anterior arms there are more than a hundred. The terminal ungrooved pinnules of the former are also thicker and more clothed with perisome than those at the same distance from the calyx on the anterior arms. But I can find no trace in any of them of any of the ovoid bodies which I have observed in some of the Philippine specimens *, and in a few other species †.

4. ACTINOMETRA GRANDICALYX, n. sp.

Description of an Individual.—Centrodorsal large and hemispherical, 10 mm. wide, with the dorsal pole free from cirri and somewhat hollowed. About 50 cirri of 23–26 moderately stout joints, the fourth of which is about square, and the 8th–10th the longest. The following ones decrease in size, and the terminal joints develop blunt dorsal tubercles, that on the penultimate being the most distinct.

Second radials partially concealed; axillaries relatively long, almost triangular, with sharp distal angles.

47+ arms, some of the rays dividing four times. The first and third divisions each of three joints, the axillary with a syzygy; the second division of two joints, the axillary without a syzygy. The first joints after each axillary closely united laterally, and bluntly wedge-shaped, the outer sides being the longer. Second brachials somewhat shorter and more oblong than the first. The third (syzygy) and the next three or four joints also nearly oblong; the following ones overlapping and rather sharply wedge-shaped, nearly twice as wide as long, becoming shorter and blunter after about the 30th joint.

First syzygium on the third brachial and the next from 13–20; then an interval of 3–9, usually 3 or 4, joints between successive syzygia.

The first pinnule (borne by the second distichal) slender, except just at the base, and very long, reaching almost 25 mm. The next one on the second joint of the tertiary arm (when present) is somewhat shorter, and that on the second brachial more so, though still more than 15 mm. long. This pinnule is longer when there are no tertiary arms.

The following ones decrease to those of the 7th and 8th joints,

* Trans. Linn. Soc. 2nd ser. Zool. vol. ii. p. 40, pl. ii. fig. 6.

† Bull. Mus. Comp. Zool. vol. ix. no. 4, pp. 11, 12.

which are not specially small. The succeeding pinnules gradually increase in length, and are also stouter with larger joints, becoming more slender again when the arm-joints decrease in size. The second and third joints of the pinnules borne by the third and five or six following brachials have slight dorsal projections, which are much more distinct on some arms than on others.

The lowest pinnules have a tolerably well-marked comb, which gradually decreases in size, and ceases after the 7th or 8th joint.

Disk naked, 30 mm. in diameter. Mouth radial, and all the arms grooved.

Perisome blackish brown; the skeleton somewhat redder, with a broad white stripe along the medio-dorsal line, which starts from the centrodorsal, and extends outwards on to the arms. Spread about 20 centim.

One specimen from Canton.

Remarks.—I know of only one other *Actinometra* with the same number and arrangement of the arm-divisions as in this type. It was obtained by the 'Challenger' at Banda, and is a much smaller specimen, with a thin flat centrodorsal. There are other species, such as *A. alternans* of the Leyden Museum, with five arm-divisions, the first four of which resemble those of *A. grandicalyx*; and there are about half a dozen species with three distichals and two palmars, as in most of the rays of the latter type. But the large size of its centrodorsal distinguishes it from all of these. I do not know of any other *Actinometra*, except *A. Bennetti*, which has so many cirri and so large a centrodorsal, which is nearly half as wide again as that of *A. robusta*.

5. ACTINOMETRA MULTIRADIATA, *Linn.*, sp.

1758. Asterias multiradiata, *Linnæus, Systema Naturæ*, ed. 10, tom. ii. p. 663.

1783. Asterias multiradiata, *Retzius, Kongl. Vetenskaps Academiens Nya Handlingar* (Stockholm, 1783), tom. iii. p. 241.

1788. Asterias multiradiata, *Linnæus, Systema Naturæ*, ed. 13, pars vi. p. 3166.

1805. Asterias multiradiata, *Bruzelius, Dissertatio sistens species cognitas Asteriarum** (Lundæ, 1805).

1816. Comatula multiradiata, *Lamarck, Syst. d'Anim. sans Vert.* ii. p. 534.

1834. Comatula multiradiata, *De Blainville, Manuel d'Actinologie*, p. 249.

* There can, I think, be little doubt that Prof. Jeffrey Bell is right in ascribing this dissertation to Bruzelius (Ann. & Mag. Nat. Hist., March 1882, p. 166).

1843. Comatula (Alecto) multiradiata, *Müller (pars), Wiegmann's Archiv*, 1843, i. p. 133.

1849. Comatula (Alecto) multiradiata, *Müller (pars), Abhandl. d. Berlin. Akad.* 1849, p. 261.

1862. Actinometra multiradiata, *Dujardin (pars), Hist. Nat. des Zoophytes, Echinodermes*, p. 210.

1879. Actinometra multiradiata; *P. H. Carpenter, Trans. Linn. Soc. Zool.* 2nd ser. vol. ii. p. 27.

The museum contains some fragments of a dried example of this species from Sumatra; but they are too imperfect to serve as a basis for a redescription of the type.

So far as I can make out, Linnæus's original description * of *Asterias multiradiata* was based upon a specimen from the Indian seas which is now in the Retzian collection of the University Museum at Lund. It was as follows:—"*Asterias radiata* radiis palmato multiplicatis pinnatis: inferioribus filiformibus." To this type Linnæus referred the *Caput Medusæ cinereum* and *C. brunnum* of Linck†. Retzius, twenty-five years later, gave a somewhat longer description ‡ of the species, to which, like Linnæus, he referred the two specimens figured by Linck. Bruzelius, in the dissertation § which has been lately attributed to his pen by Prof. F. J. Bell, repeated the descriptions of Linnæus and Retzius, the latter with slight modifications; but he expressed a doubt as to whether Linck's *C. brunnum* belonged to this type. This doubt seems to me fully justified; for, so far as I can judge from Linck's figures, *C. brunnum* is an *Antedon*, while *C. cinereum* is an *Actinometra*, though not identical with the type specimen of *Asterias multiradiata*. Lamarck || merely repeated the Linnæan name and reference to Linck, with the remark that the species might have fifty or sixty arms; but he did not refer any of the specimens collected during Peron's voyage to this type. This, however, was subsequently done by Müller¶, who had personally examined the Retzian specimen at Lund. It belongs to a rather small section of the genus (*Actinometra*) in which there are three joints in the first division of the rays, but only two in

* 'Systema Naturæ,' ed. 10, tom. ii. p. 663.

† 'De Stellis Marinis liber singularis' (Lipsiæ, 1783), p. 55, tab. xxi. n. 33, tab. xxii. n. 34.

‡ 'Kongl. Vetenskaps Academiens Nya Handlingar' (Stockholm, 1783) tom. iii. p. 241.

§ 'Dissertatio sistens species cognitas Asteriarum,' Lundæ, 1805.

|| 'Syst. d'Anim. sans Vert.' ii. p. 534.

¶ 'Abhandl. d. Berlin. Akad.' 1849, p. 261.

the second and subsequent divisions, while all the axillaries are syzygial or double joints.

Müller does not seem to have regarded the number of joints in the successive ray-divisions as of specific value; and he grouped under the same specific name as that of the Linnæan type some *Comatulæ* in the Bonn and Paris Museums, the latter from the voyage of Peron and Lesueur. These have three joints in the second and third ray-divisions as well as in the first; and I have accordingly removed them from the type of *Actinometra multiradiata*, and have described them under the name of *A. Peronii* *.

There is, however, a dry specimen from Peron's voyage in the Paris Museum which does agree with the Linnæan type; and it was referred to this by Müller, along with a fine spirit-specimen of *A. Peronii* from the same voyage, and two others brought by Quoy and Gaimard from the Moluccas. One of these last is *A. Peronii*, and the other *A. multiradiata* in the restricted sense.

Two individuals of this species were dredged by the 'Challenger' at Banda; and I have thought it desirable, for the sake of other workers, to redescribe the type from them and from my notes of Quoy and Gaimard's example just referred to. The Linnæan specimen and that from Peron's voyage in the Paris Museum are dry and reduced to many fragments. For the privilege of examining them I am indebted to the kindness of Professors Quennerstedt and Lundgren, and of Prof. E. Perrier.

ACTINOMETRA MULTIRADIATA, *Linn.*, sp.†

Centrodorsal a thick disk, sometimes almost columnar, with the dorsal pole hollowed, and bearing a single or partially double row of 20–30 moderately stout marginal cirri. They may have 30–40 joints, of which the fifth is usually longer than wide and the next two or three the longest, least markedly so in the older specimen. The next few joints shorten rather rapidly, and commence to overlap on the dorsal side. This is most marked in the following joints, which are nearly square and somewhat compressed laterally. Small spines gradually appear near their distal edges, and increase in distinctness up to the penultimate joint.

First radials just visible, least so in the larger specimen; the second relatively long, more or less hexagonal, and partly united laterally. Axillaries pentagonal, about twice their length. The rays and their subdivisions are well separated from one another.

* 'Notes from the Leyden Museum,' vol. iii. pp. 214–217.

† Published by permission of the Lords Commissioners of the Treasury.

They may divide four times: the first division of three joints, the axillary with a syzygy; the second and subsequent ones of *two* joints, the axillary also with a syzygy. The first distichals are nearly oblong; but the first palmars are more wedge-shaped and longer in proportion to their width.

40–60 arms of 120–150 joints. First brachials tolerably oblong, or slightly unequal-sided; the second (syzygy) and next few joints oblong. The following ones almost triangular, with overlapping coarsely spinous distal edges, which are not very oblique, as the joints are relatively short and only half as long as broad. From about the fortieth onwards the joints become more oblong as the arms narrow, and the terminal ones are squarer. The anterior arms may be slightly the longer.

First syzygium on the second brachial; the next from 15–30, usually about 20. Then an interval of 4–8, usually 5 or 6, joints between successive syzygia.

The second distichals bear long pinnules (nearly 30 mm.), which are moderately stout at the base, but soon become more slender. The next ones are on the first joints after each axillary; and the length decreases to the pinnules of the fifth and sixth brachials, which are not specially small. The following ones slowly increase again, but not to any great extent; so that the terminal pinnules are not unusually long. The last 12 or 15 joints of the lowest pinnules bear a terminal comb, which may extend out to about the 15th arm-joint; and the edges of the pinnule-joints are fringed with spines.

Mouth radial, or nearly so. Disk 15 mm. in diameter, may be naked, or have a few calcareous nodules on it.

Colour blackish brown. Spread 25 centim.

Two specimens from Banda.

Remarks.—In the smaller specimen the first radials are more completely visible, and the distal edges of the distichal and palmar joints are smooth; but in the larger the first radials are hardly visible, and the distichal and palmar joints have slightly raised distal edges, with a tendency to the same coarsely spinous character that appears on the arm-joints. In the smaller specimen, too, the cirri are longer, and have more numerous joints, the number reaching 35 or 40; while in the larger individual it falls to 26.

In Quoy and Gaimard's specimen the distichal and palmar pinnules have a slight keel on the second and third joints, traces

of which sometimes extend out on to the arms as far as the 7th joint. But it does not occur in the 'Challenger' specimens.

In the dry specimen from Peron's voyage there is a tolerably well-marked median tubercle at the junction of the first and second distichals, of which there is hardly any trace in the other examples; while the syzygial interval appears to be 10–13 joints.

In the original example at Lund the centrodorsal partly conceals the second radials, which are closely united laterally, and the axillaries are more triangular; while the position of the second syzygy may be from the 20th to the 39th brachial.

The mutilated specimen from Sumatra belonging to the Hamburg Museum resembles the larger of the two 'Challenger' individuals in the more complete concealment of the first radials, and in the small number of cirrus-joints, which may be reduced to 23. The second syzygy also may be as early as the 11th brachial, while the later syzygial interval may rise to over 20 joints.

There are about six other species of *Actinometra* which resemble *A. multiradiata* in the number and arrangement of the ray-divisions; but the large size of its centrodorsal, the overlap of its arm-joints, and the fringe of spines on them and on the pinnule-joints are sufficient to distinguish it from them.

6. ACTINOMETRA MEYERI, n. sp.

This is rather a large species from Australia, distinguished by the thin centrodorsal and the small number of cirri which it bears. The rays divide three times, each division consisting of three joints, the axillary with a syzygy. The arm-joints are triangular, and overlap rather markedly. The lowest pinnules appear to have been long and slender; but in the dry specimen it is difficult to make out their relative proportions, a point of much importance for specific determinations. The museums at Dresden and Vienna contain some individuals in spirit which are probably identical with the dry Hamburg specimen, so far as I can judge from my notes, without having made a direct comparison; and I prefer therefore to reserve a detailed description of the type until I have made a closer examination of the spirit-specimens. I propose to name it after Dr. A. B. Meyer, the accomplished Director of the Zoological Museum at Dresden, who collected some fine individuals during his residence in the Philippine Islands.

7. ACTINOMETRA BENNETTI, *Mus. Leyd.* sp.*

The Hamburg Museum contains two examples of this fine species, which differ in points of detail from the somewhat mutilated type specimens in the Leyden Museum. One of them, which was obtained at Singapore, a new locality for the type, is remarkably perfect; while the other (*sine patria*) is considerably mutilated, nothing remaining but the calyx, arm-bases, and disk. As in the type specimens, the mouth of this individual is nearly radial, though not absolutely so; while it is absolutely interradial in that from Singapore. I find that variations of this kind are not uncommon in species with very numerous arms, and that the position of the mouth relatively to the rays is far less constant than in the simpler forms with 10–40 arms.

The centrodorsal reaches 12 mm. in diameter; and in both individuals the cirri are much longer and stouter than in the type. Some of them reach 35 mm. in length, and consist of the same number of joints, 8 or 10 more than in the type; while the basal joints are very broad, and there are few, if any, that are at all longer than broad. The calyx and ray-divisions are of the same nature as in the type, each division of three joints, the axillary with a syzygy. In the Singapore specimen the surface of the joints is smooth and even; but in the other their edges are slightly raised and somewhat spiny. In both individuals the fourth and following brachials are almost devoid of the alternating backward projections which are visible in the corresponding joints of the type specimens; but some arms of the Singapore form have slight tubercles in the same positions. Its remaining arm-joints are essentially similar to those of the type specimens, except that they are somewhat wider relatively to their length, while the second syzygy is rather further from the calyx; though I have not found it as far out as the 38th joint, as in the individual examined by Böhlsche.

Both specimens are remarkable for the great length of their lowest pinnules, which may reach 40 mm., but are relatively slender, none of their joints, except the broad basal ones, being specially stout. These lower pinnules, and in fact the whole arms, of the Singapore individual are much more clothed with perisome than are those of the type specimens at Leyden.

* The literature of this species will be found on p. 212 of 'Notes from the Leyden Museum,' vol. iii

On the Ascidians collected during the Cruise of the Yacht 'Glimpse,' 1881. By H. C. Sorby, LL.D., F.R.S., and W. A. Herdman, D.Sc., F.L.S., Professor of Natural History in University College, Liverpool.

[Read June 1, 1882.]

(Plates X. & XI.)

The cruise of the 'Glimpse' round the South coast of England commenced early in May, and ended in October, 1881. Very little dredging was done from the yacht in the open sea. Nearly all was done in water less than 12 fathoms deep, by means of a light but most efficient dredge, 25 inches wide, worked by Dr. Sorby himself from the stern of the gig. With a crew of two rowers there was no difficulty in dragging this dredge, which often brought up as much as could be "docked" and lifted into the boat. A new kind of grapple was also used, especially in the early part of the cruise. By thus dredging from a boat, places could be easily examined where nothing could be done from a yacht. Possibly the successful results are to a great extent due to this cause, since certain objects were more abundant in many of the sheltered places than in the more open sea; and probably some had not been previously explored. Many thousand specimens of Ascidians must have been dredged during the cruise. Comparatively few specimens of some of the more common species were preserved; but the individuals of the rarer sorts were retained. All the specimens kept were placed in the hands of Professor Herdman, who has carefully investigated them and given the scientific descriptions, Dr. Sorby confining himself to certain particulars observed when the animals were alive, and to the general manner of their occurrence. Towards the close of the cruise the relation between the different organisms and the general character of the bottom in various localities became more and more apparent; and it therefore seems desirable to give the following particulars:—

Southampton: sandy mud, with many dead shells. *Cowes*: sandy mud. *Poole Harbour*: extensive mud banks, with intervening channels several fathoms deep, the bottom of which consisted of dead shells and gravel; it was in these channels that the Ascidians were dredged, along with many sponges &c. *Hoole's Bay*: wide expanse of mud and narrow channels with muddy bottom, but not deep anywhere. *Weymouth Bay* and *Portland Roads*: sandy mud and pebbles, with dead shells. *Dartmouth*: coarse and finer shingle, with dead shells; strong tidal current. *Torbay*: some parts clean gravel, and others clean sand, washed by wave-action. *Orwell* and *Stour*: extensive mud banks with relatively deep

channels, having a clear shingly bottom; very many sponges. *Brightlingsea*: sandy mud, with stones and dead shells.

Ascidiæ Simplices.

Fam. 1. Clavelinidæ.

Clavelina lepadiformis, *O. F. Müller.*

The only locality where this species was met with was Dartmouth, where a single large colony of well-grown individuals was dredged in July, on a shingle bank inside the harbour near the entrance, off Gunfield, in 2 to 6 fathoms, where the tide runs strong. In the spirit-specimens the lines on the thorax are between cinnamon and straw-colour. The largest individuals are about an inch in length. Most of them had embryos or tailed larvæ in the peribranchial chamber; and one had a specimen of *Modiolaria marmorata* imbedded in the test behind the branchial sac.

Fam. 2. Ascidiidæ.

Ciona intestinalis, *Linn.*

This common species was obtained at various localities varying in depth from 2 to 6 fathoms.

At Dartmouth a large number, probably some hundreds, were found sticking to the bottom of the yacht when cleaned on July 26th. They were of various sizes, from an inch downwards.

Dr. Sorby's impression is that the attachment took place at Poole, at the end of May or beginning of June. "It was there that I first collected specimens of this species; and though in previous years we had been at all other places visited this year except Poole, Ascidians were absent, or present to so limited an extent that neither myself nor any of the crew noticed them on the bottom of the yacht. If the larvæ attached themselves at Poole, the well-grown individuals must have been about two months old when observed at Dartmouth. They could not have been more than three months old, since the yacht was cleaned before starting from the river Colne in Essex early in May. After visiting Poole we remained four weeks at Weymouth, then a week at Portland, where this species was also found, and afterwards three weeks at Dartmouth before the Ascidians were seen. We did nearly the same in 1880 at the same time of the year; and yet none were remarked when the copper was cleaned. On the whole, then, though the evidence is not quite conclusive, all the facts seem to agree with the view expressed above, and that the specimens had grown to the length of an inch in about two

months; but it is just possible that some might be three months old, and some only one."

About a dozen specimens of moderate size were preserved. They are of rather elongated form, perhaps on account of the unusual conditions in which they grew; and the test is thin and transparent. The genital glands are well developed, and the specimens seem sexually mature. When living, some of them had a slight orange tint, while the specimens from Poole and Portland were quite pale.

ASCIDIA PLEBEIA, *Alder*.

A single specimen was dredged off Brightlingsea, Sept. 27th, just west of the beacons outside the harbour, in 2 fathoms. The species was not met with elsewhere; and this locality was only dredged for a few hours. The specimen obtained is of fair size. The test is translucent, and of a light-brownish hue in place of the usual dull green. It is a good deal covered with Hydroids and Polyzoa.

ASCIDIA ASPERSA, *O. F. Müller*.

This common species was found at a number of localities, the depths ranging from 2 to 6 fathoms. The specimens from Poole and Portland are a rather elongated variety, with the test thin and smooth on the outer surface. These, when living, measured up to 2 inches in length. They were larger and less pigmented round the apertures than the ordinary rugose forms.

ASCIDIA VIRGINEA, *O. F. Müller*.

This species was common in the Orwell at Pin Mill in the middle of September, at a depth of 2 or 3 fathoms. When alive the colour varies from orange to green of variable intensity.

ASCIDIA MAMILLATA, *Cuvier*. (Plate X. figs. 1–5.)

Three specimens of this fine species, one very large and one small, were obtained at Portland inside the breakwater during August, in 3 or 4 fathoms. The small specimen, which is remarkably mamillated, was dredged on August 16th from 3 fathoms of water. The largest specimen, when alive, was 4½ inches long, 3 inches broad, and 2 inches thick. It was of a dull greyish-white colour.

This is a common Mediterranean species; but, so far as we know, it has not previously been found in our seas *. Probably it

* Since the above was written Mr. S. O. Ridley has informed us that there are in the British Museum two specimens of a large *Ascidia* collected at Weymouth by Dr. Bowerbank, and which are probably *A. mamillata*. We have not yet had an opportunity of examining these specimens.

does not extend much further north than the Channel. It does not occur in Traustedt's list of the Simple Ascidians of the Danish seas*.

Ascidia mamillata has a very characteristic appearance, and is easily recognized. Heller† gave a good general description of the species in 1875; and, more recently, Julin ‡ has made it the subject of one of his investigations into the nature of the dorsal tubercle and neural gland. The arrangement of this "hypophysary" system in the largest specimen is exactly as described by Julin from an adult animal; but in neither of the smaller specimens is there any trace of a dorsal tubercle or terminal aperture into the mouth of the branchial sac (Pl. X. fig. 4). In these specimens there is also no peritubercular area. As noticed by Heller, the anterior part of the dorsal lamina is double for a considerable distance, nearly as far back as the nerve-ganglion which is close to the atrial siphon (Pl. X. fig. 3). The tentacles are of three sizes (Pl. X. fig. 2). In the moderately large specimen there are twenty large tentacles and twenty smaller, and about the same number of very minute ones which alternate with the others, but only occur in some of the spaces (Pl. X. fig. 2, *tn''*). Opposite the end of the dorsal lamina two large tentacles occur close together; and opposite the end of the endostyle seven large and seven smaller are placed alternately, but close, while the minute ones are entirely absent in this region.

Fam. 3. Cynthiidæ.

Styela grossularia, *van Beneden.*

This very common species was found in abundance on dead shells at various places in the English Channel. The specimens are all of the squat, blister-like form, and are mostly of small size. They occur attached to dead shells, stones, and the tests of other Ascidians.

There are several specimens from Cowes, Southampton, and the Orwell, which belong to a well-marked variety. In shape they differ greatly from the typical form, being elongated antero-posteriorly. The specimen from Cowes is $\frac{5}{8}$ inch in length and only $\frac{3}{8}$ in its greatest breadth. The apertures are placed at the extre-

* "Oversigt over de fra Danmark og dets nordlige Bilande kjendte Ascidiæ Simplices," Vidensk. Meddel. Nat. For. Kjöbenhavn, 1880.

† "Untersuchungen über die Tunicaten des Adriatischen Meeres," ii. Abth., Denksch. der k. Akad. der Wissensch. Wien, Bd. xxxiv. 1875.

‡ "Recherches sur l'organisation des Ascidies simples," part ii., Archives de Biologie, vol. ii. 1881.

mities of the anterior end. From a consideration of the external appearance only, this form would certainly be referred to a different species from the typical blister-like *Styela grossularia*; but the internal characters are the same in both. The oblong variety shows the peculiarly abnormal branchial sac, with a single well-developed longitudinal fold at the dorsal end of the right side, the other seven being rudimentary and represented merely by one or more rows of narrow meshes formed by an approximation of two or more internal longitudinal bars. In the specimens from Cowes and Southampton the dorsal tubercle is of the ring-like type sometimes found in this species*.

The specimen from the Orwell has several young individuals of different sizes adhering to the outer surface of the test. These are neither markedly of the typical squat nor of the elongated form.

STYELA AGGREGATA, *O. F. Müller.*

This interesting species was obtained in considerable quantity in July at Dartmouth, just inside the harbour off Gunfield, in 3 or 4 fathoms of water. The specimens were found adhering together in thick-set clusters on pebbles and dead shells. The individuals did not exceed half an inch in length.

Dr. Sorby says in his notes :—" This is a charming and attractive species. When living, the colour is a peculiar orange, of a fine clear tint, deeper on the long wide openings. When in water, alive, and seen in some positions, it looked like a small terra-cotta vase; but did not live long in my aquarium."

This species was first found in British seas by Prof. Edward Forbes at Dartmouth, but in rather deeper water, 12 fathoms. He referred it to the *Ascidia aggregata* of the 'Zoologia Danica,' and described it briefly in his 'British Mollusca,' vol. i. p. 41, giving also a figure. His specimens were considerably larger than ours, but did not differ otherwise. The species has since been more fully described by Kupffer† and Traustedt‡. These northern specimens, if the same species, seem to be much larger than ours, and to have a stronger and more corrugated test. Kupffer, however, remarks upon the variability of the species; consequently the Dartmouth specimens, if adult, may be a small and smooth-skinned variety.

* Herdman, "On the 'Olfactory Tubercle' as a specific character in Simple Ascidians," Proc. Roy. Phys. Soc. Edin. vol. vi. p. 254, 1880–81.

† 'Jahresberichte der Kommission zur Untersuchung der deutschen Meere in Kiel.' Berlin, 1874. VII. Tunicata.

‡ 'Oversigt over de fra Danmark og dets nordlige Bilande kjendte Ascidiæ Simplices,' Kjöbenhavn, 1880, p. 16.

It seems probable that this species reproduces by gemmation, as suggested by Forbes in 1853. The adult individuals give off long branched stolon-like prolongations from the test near the posterior end of the body; and on these (the "root-fibres" of Forbes), which form a matted mass by which the individuals are united together into clumps, are found young specimens of different sizes. Further observations on the living animal in regard to this point are much needed.

POLYCARPA POMARIA, *Sav.* (?).

Three specimens of a small *Polycarpa*, found sticking together by their bases at Brightlingsea, in 2 fathoms, and one specimen found at Portland in 3 fathoms, are referred with some doubt to this apparently very common and polymorphic species, which includes *Cynthia coriacea* of Alder, *Cynthia tuberosa* of Macgillivray, *Polycarpa varians* of Heller, *Styela pomaria* of Traustedt, and, possibly, *Cynthia sulcatula* and *C. granulata* of Alder.

The shape of the Brightlingsea specimens is irregularly ovate and rather depressed. The largest specimen is nearly $\frac{3}{4}$ inch broad (dorso-ventrally) and $\frac{1}{2}$ inch wide, while it is only $2\frac{1}{2}$ to $\frac{3}{8}$ inch long (antero-posteriorly). The other two specimens are rather smaller, about $\frac{1}{2}$ inch in the greatest extent. The Portland specimen is rather higher, being $\frac{5}{8}$ inch dorso-ventrally at the posterior end, $\frac{1}{2}$ inch antero-posteriorly, and $\frac{3}{8}$ inch laterally. They are all attached by a large flattened area at the posterior end. The apertures are both placed on the wide anterior end, moderately far apart; they are sessile and inconspicuous in the spirit-specimens. The surface of the test is rough and corrugated, and slightly incrusted here and there with adhering foreign bodies. The colour, after having been kept in spirit, is a dark reddish brown, except the specimen from Portland, which is greyish white.

The test is thick and very tough, and white on section. The mantle is strongly muscular, and is closely united to the inner surface of the test. The branchial sac is elongated dorso-ventrally, and has four folds on each side. There are four or five internal longitudinal bars on each side of a fold, and only two or three in the interspace, where the meshes are transversely elongated, and contain about eight stigmata each; they are occasionally divided by a narrow horizontal membrane. The tentacles are simple, numerous, closely placed, and large and small alternately.

The dorsal tubercle is nearly circular in outline, and has both

horns turned inwards. The genital glands are very numerous and are scattered over the inner surface of the mantle, projecting into the peribranchial space.

The whole peribranchial cavity and the spaces behind the folds of the branchial sac in the specimen from Portland were packed full of tailed larvæ. The specimen was taken in August.

POLYCARPA COMATA, *Alder*. (Plate X. fig. 6.)

This species was found at several places, more especially at Southampton in May, at a depth of 3 fathoms, and at Pin Mill, on the Orwell, in September. Most of the specimens are about $\frac{1}{2}$ inch in their greatest length.

Kupffer * described this species fully in 1874.

Fam. 4. MOLGULIDÆ.

MOLGULA OCCULTA, *Kupffer*.

This species was found at Torbay in two different conditions. Most of the specimens had a uniform coating of fine sand; but some from 4 fathoms, off Daddy's Hole Plain, were covered with small stones and fragments of shell.

The characters agree fairly well with Kupffer's description of this species in the 'Jahresberichte,' p. 224, and with Heller's figures of specimens from the Adriatic †.

There are seven folds on each side of the branchial sac, with three or four internal longitudinal bars on each fold, and one in the interspace. The tentacles are moderately branched; there are six large ones, and three or four series of smaller ones placed alternately.

The dorsal tubercle is large, cordate, with both horns turned inwards, and is reversed, the aperture being directed posteriorly, towards the angle of the peritubercular area.

MOLGULA CÆPIFORMIS, n. sp. (Plate XI. figs. 1–8.)

This species appears to be undescribed. It was only met with in Hooles Bay, which may be called a shallow muddy salt-water lake $1\frac{1}{2}$ mile long, $1\frac{1}{4}$ mile wide, with deeper channels, and a narrow opening at Poole into the main harbour. Two specimens were dredged at the end of May at a depth of 1 fathom; and their resemblance, when living, to small onions was so great as to make the name *cæpiformis*, which we have given it, very appro-

* 'Jahresberichte der Kommission zur Untersuchung der deutschen Meere in Kiel.' Berlin, 1874. VII. Tunicata.

† "Untersuchungen ü. d. Tunicaten d. Adriat. u. Mittelm. iii. Abth.," Denksch. k. Akad. Wissen. Wien, Bd. xxxvii. p. 267, Taf. vi. figs. 14–15 (1877).

priate. No other Ascidians were found at Hooles Bay; but all parts of it were not sufficiently examined.

The specific description is as follows:—

External appearance.—Shape nearly globular (Pl. XI. fig. 1), somewhat compressed laterally, and rather elongated antero-posteriorly, not attached. Anterior end truncated, slightly produced; posterior wide and rounded; dorsal and ventral edges equally convex. Apertures conspicuous, on large mamilliform projections placed at the dorsal and ventral extremities of the anterior end; both are directed anteriorly and are obscurely lobed. Surface even and nearly smooth, being merely slightly roughened in places, and having here and there a few particles of sand and fragments of algæ attached. This is especially the case towards the posterior end. There are no hairs or other processes developed, and there is no incrusting coat. Colour milk-white, with here and there a hyaline bluish tinge. Length (antero-posterior) $\frac{3}{4}$ inch, breadth (dorso-ventral) $\frac{5}{8}$ inch, thickness (lateral) $\frac{1}{2}$ inch.

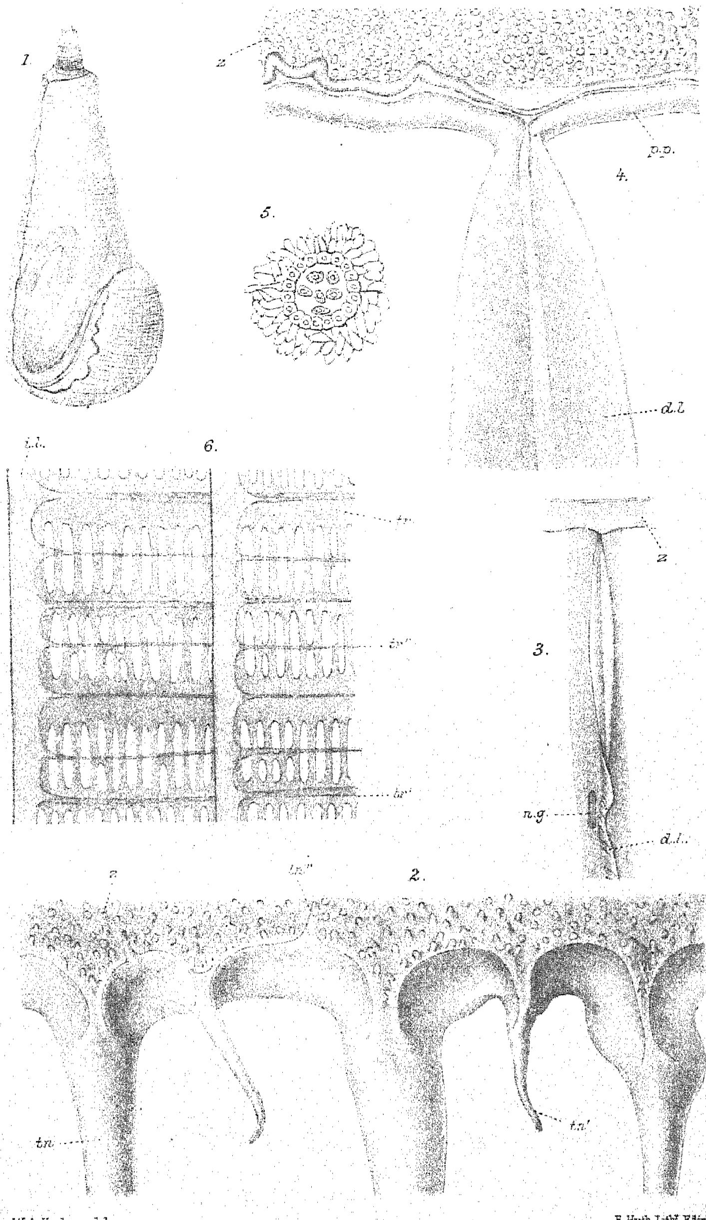
Test thick and cartilaginous, but soft and rather flexible, moderately tough; whitish grey in section; smooth and glistening on the inner surface, with a hyaline blue tinge.

Mantle very thin and membranous, not adhering to the test; musculature feeble, chiefly round the posterior end, dorsal and ventral edges, and on the siphons and their immediate neighbourhood (Pl. XI. fig. 2). Siphons long and conical; sphincters not very strong.

Branchial sac large, with seven folds on each side; they converge towards the œsophageal aperture; and the seventh pair, next the endostyle, are very slight. Internal longitudinal bars broad and ribbon-like; four on the uppermost surface of each fold, and none in the interspaces (Pl. XI. fig. 4). Transverse vessels not well marked, distant, provided each with a wide horizontal membrane. The meshes, formed by the intersection of these membranes with the internal longitudinal bars, are large and elongated vertically. Stigmata rather irregular, in some places much curved, in others almost straight, on account of the secondary vessels being here and there coiled spirally, while between the spirals, sometimes for considerable distances, they are more or less straight and run longitudinally.

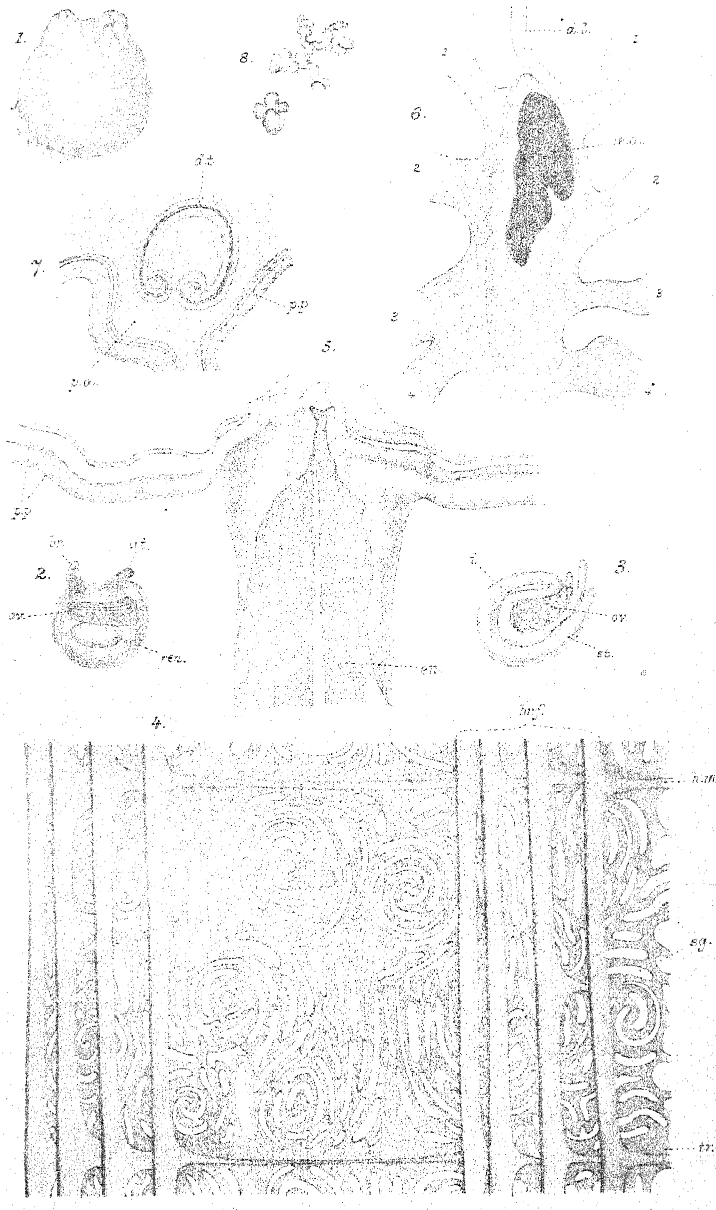
Endostyle rather inconspicuous. The hypopharyngeal groove ends cæcally at its anterior extremity, and does not communicate with the right and left peripharyngeal grooves (Pl. XI. fig. 5).

Dorsal lamina short and not wide (Pl. XI. fig. 6, *d. l.*); a plain delicate membrane with no teeth or ridges.



W. A. Herdman del. F. Huth, Lith^r Edin^r

1–5 ASCIDIA MAMILLATA, Cuv.
6 POLYCARPA COMATA, Alder.



W. A. Herdman del.

F. Huth, Lithʳ Edinʳ

MOLGULA CÆPIFORMIS n. sp.

Tentacles rather small and much branched, very numerous, and of different sizes placed irregularly.

Dorsal tubercle rather large, but placed in a small peritubercular area (Pl. XI. fig. 7). Shape broadly cordate, with both horns turned inwards and the aperture directed posteriorly.

Alimentary canal on the left side of the branchial sac. Œsophageal aperture rather more than halfway down the dorsal edge. Stomach not very distinct (Pl. XI. fig. 3, *st.*). Intestine long, its loop being turned anteriorly and then dorsally, so as to enclose the left genital mass and bound it anteriorly.

Genital glands large, forming transversely elongated yellow masses in the centre of each side (Pl. XI. figs. 2 and 3, *ov.*); left one in the space between the second part of the intestine and the rectum; right one anterior to the renal organ, on the right side of the mantle.

Renal organ elongated transversely, not so large as the right genital mass (Pl. XI. fig. 2, *ren.*), containing a number of yellowish-brown, irregularly branched, and nodulated concretions (Pl. XI. fig. 8).

Locality. Hooles Bay; 1 fathom; end of May 1881: 2 specimens. The above description is taken from the larger specimen.

The only compound Ascidians preserved in the collection were a few colonies of *Botryllus schlosseri*, Savigny, and several small colonies of *Leptoclinum albidum*, Milne-Edwards, growing over the outer surface of the test of an *Ascidia*. Both species were from the Orwell, 2–3 fathoms.

DESCRIPTION OF THE PLATES.

Plate X.

Figs. 1–5. *Ascidia mamillata*, Cuv., and details. 1. Animal with the test removed, to show the mantle and the relations of the branchial sac and intestine, natural size. 2. Part of circlet of tentacles and papillated zona præbranchialis, highly magnified. 3. Anterior part of dorsal lamina, slightly enlarged. 4. Anterior end of previous figure, more magnified. 5. Optical transverse section of a papilla of the zona præbranchialis.

Fig. 6. *Polycarpa comata*, Alder. Portion of the branchial sac, seen from the inside, magnified.

Plate XI.

Figs. 1–8. *Molgula cæpiformis*, n. sp., and details of anatomy. 1. Animal, of the natural size, from the right side. 2. The same, with test removed. 3. The alimentary canal and left genital mass in their natural position, slightly enlarged. 4. Portion of branchial sac, seen from the inside, magnified. 5. Anterior end of endostyle, to show the relations

of the hypopharyngeal and peripharyngeal grooves. 6. The œsophageal aperture &c., magnified. 7. Dorsal tubercle, magnified. 8. Concretions from the renal organ.

Explanation of the Lettering.

d. l., the dorsal lamina.
d. t., the dorsal tubercle.
en., endostyle.
h. m., the horizontal membrane of the branchial sac.
i., intestine.
i. l., internal longitudinal bar.
n. g., the nerve-ganglion.
ov., the genital glands.
p. a., peritubercular area.
p.p., peripharyngeal bands.
ren., renal organ.
sg., the stigmata of the branchial sac.
st., stomach.
tn., *tn.'*, *tn.''*, tentacles.
tr., *tr.'*, *tr.''*, the transverse vessels of the branchial sac.
z., the zona præbranchialis.

On a probable Case of Parthenogenesis in the House-Spider, (*Tegenaria Guyonii*). By F. Maule Campbell, F.L.S.

[Read June 15, 1882.]

For some years past I have confined Spiders with the view of observing their habits. During the autumn of 1878 I imprisoned an adult female *Tegenaria Guyonii*, Guérin (=*T. domestica*, Blackw.), just after her last moult. In the following May she laid eggs, which were hatched; and as her capture had followed so closely on the adult stage, I could scarcely think she had been fecundated, and suspected that the cause of fertility was agamic reproduction.

In the autumn of 1880 I confined three females of the same species as above, having previously satisfied myself as to their immaturity. They moulted successfully at the end of September; but two died during the winter, and the third (May 1881) laid eggs which were non-productive. During the same month the first-mentioned Spider, a few days prior to death, made a cocoon, with the same result. The eggs became shrivelled and hard, while a few retained nearly their original form, but turned green-black in colour. A female (*T. Guyonii*, Guérin) which I had caught adult in December 1880, gave me in July 1881 a large brood. In May 1881 I confined two immature females of the same species. Both cast their skins twice, the last occasion being in September. One died during the winter; and the other has afforded the material for this paper.

I kept this Spider like the others, each one in a separate flint-glass bottle, $4\frac{1}{2}$ inches high from shoulder to base, and 4 inches in diameter; I covered the mouth with a glass slip. As soon as she became accustomed to her prison, she began to fasten threads,

as high as her spinnerets could reach, from the side to the bottom of the bottle. Each thread enabled her to carry another still higher, until in about six weeks, always working at night, she reached the shoulder. By that time the sides were speckled with attachments, there being as many as seventy in one square half inch. Her home soon became utterly unlike the well-known cob of this species, consisting as it did of a cube of confused cross threads, which were frequently broken by the insects given her, and her energetic pursuit of them. She often was quite at a loss as to the direction in which her prey had settled, as might be expected from her inexperienced use of a net which was specially adapted to her new condition of life. Sometimes during an exciting chase, when at the bottom of the bottle, she would move her whole body from side to side in a slanting position, evidently making the best use of her sight. She would then make a dash to strike at her object with her front legs; and her spinnerets would be widely separated, trailing threads at each movement of the abdomen. Spiders live long without food; and I was careful not to overfeed. Her usual allowance was a blow-fly every second or third day, and an occasional daddy-long-legs when in season. During the winter she sometimes fasted for a week; for the relays of flies which I had to rear did not always follow. From February 1882 I fed her more regularly.

The habits of the females of this species, spending, as they do, a comparatively sedentary life in dry places, renders it difficult to see how they can obtain water, except during their occasional excursions; yet a frequent supply or a damp atmosphere is necessary to many Spiders. I have kept a *T. Guyonii* ♀ 27 months without any liquid except that which she derived from insects. In the case I am detailing, it was, however, required. In December, after six weeks' absence, I found the Spider lying helpless at the bottom of the bottle, with her legs drawn close to her body; I immediately filled a tube with water, and dropped some on her back and in front of her. She quickly balanced herself, and wetting the last joints of her palpi, placed them on her maxillæ. This she did five times, when she advanced, and lowered her whole body so that the maxillæ were dipped in the water. Thus she remained apparently motionless for a few seconds, when she raised herself to her normal position, and repeated the draught after an interval of a few minutes. Shortly afterwards she mounted to her usual roost at the shoulder of the bottle, with her abdomen considerably distended. On removing the glass cover a few days later, I

found adhering to it her first and third leg, which were broken off just below the trochanter. I suppose the tarsi had been caught against the rim of the bottle, and she had dismembered herself to obtain freedom, a common occurrence with Spiders. Towards the end of March she began to strengthen the supports to that part of the web which was her usual resting-place. This was done by spinning from the bottom of the bottle an irregular loose vertical shaft, which was partly covered with the remains of her victims, the threads taking no particular direction. Her web was now still more unlike the cob of her species; but I have found that other *T. Guyonii*, when about to lay eggs in the-same-shaped vessel, made the same structure. On the 7th of April, after an absence of three days, I found she had woven the ordinary cocoon, viz. two sheets of silk with the eggs between them. She must have been disturbed, probably by a strong fly, in her first attempts; for a few eggs were hanging loosely on threads away from the rest. I found her dead on the 10th of May, and put her in spirits; but I think, from dissection, she died prior to that date. On the 7th of June I thought there was some movement in the cocoon, when the two sheets were carefully separated; then I found that two Spiders were hatched, twelve eggs still retained vitality, while the rest were hard and shrivelled.

The fertility of this Spider after a confinement of eleven months, during which time she twice moulted, can only be explained by one of the following alternative causes:—(1) that she was impregnated previous to the casting of the two exuviæ, in an early and therefore immature stage; (2) that parthenogenesis occurs in the Araneidea.

The researches of Mégnin *, Kramer †, Haller ‡, and Michael § show that the females of some Acarina, and more especially of the Dermaleichidæ, couple with the males prior to their final moult, and that practically there are two stages of sexual maturity:—1st, of the "vulve d'accouplement;" 2nd, of the "vulve de ponte." On the other side, Mr. Beck ‖ and, lately, M. Berlese ¶ have

* 'Les Parasites et les Maladies parasitaires,' pp. 180–220, and Journ. Anat. et Phys. 1872, p. 337, 1873, p. 369, and 1874, p. 225.

† Giebel's Zeit. für ges. Naturwiss. 3. Folge, 1881, vol. vi. pp. 417–451.

‡ "Ueber d. Bau d. vogelbewohnenden Sarcoptiden," Zeit. f. wiss. Zool. 1881, Bd. xxxvi. p. 366.

§ "On the Reproductive System of some of the Acarina," Journ. Quek. Micr. Club, Nov. 1879, vol. v.

‖ "A short Description of *Acarus* and its Agamic Reproduction," Journ. Micr. Sci. vol. xiv. p. 30.

¶ "Il polimorfismo e la partenogenesi di alcuni acari," Bull. Soc. Ent. Ital., ann. xiii. p. 290.

related cases of parthenogenesis among the Acari. Both hypotheses are therefore supported by analogy from a related group. Unfortunately, disintegration has prevented a satisfactory examination of the spermathecæ of the Spider in question; but I am inclined to believe that the case is one of agamic reproduction, inasmuch as I can find no lumen in the exuvia through which impregnation could have taken place. Bertkau states ("Ueber den Generationsapparat der Araneiden," Archiv für Naturgesch., vol. 1, year 41, p. 253):—"Nur so viel ist gewiss, dass die Spinnen mit oder nach der letzten Häutung geschlechtsreif werden."

I purpose to continue my investigations on this subject, and hope that others may do the same.

Description of new Species of *Donax* in the Collection of the Author. By Sylvanus Hanley, F.L.S.

[Read June 1, 1882.]

(Plate XII.)

Since 1843, when I first described three new species of *Donax*, four important monographs have appeared of this now large genus. The first, by Reeve, strangely ignored the paper I had published in the 'Proceedings of the Zoological Society' for 1845, but figured the same specimens with the same names from the Cumingian collection. The last, and critically the best, is the posthumous production of the late Victor Bertin, who declares that both Reeve and Sowerby have wrongly delineated my *Donax assimilis*. Premising, therefore, that the *Donaces* which follow cannot even be regarded as varieties of any delineated in the four monographs above alluded to (so peculiar are they in their form and proportions), I will proceed to describe them:—

Donax Mesodesmoides, n. sp. (Plate XII. fig. 1.)

T. magna, valida, oblonga, satis convexa, curvato-subcuneiformis, valde inæquilateralis, nitida, lævis, sub epidermide cinereo-flavescente extus omnino candida, intus præcipue purpurascens; lateris antici extremitas attenuato-rotundata, lateris postici rotundato-subtruncata. Area postica angusta rugis erectis flexuosis subremotis transversis, lineisque radiantibus humilioribus decussata. Margo dorsalis antice incurvatus, modice declivis; margo ven-

tralis utrinque ascendens, in medio convexus, flexura nulla. Ligamentum breve. Dentes laterales nulli.

Long. 1·5, lat. 1 poll. *Hab.* —— ?

This unique and aberrant species reminds one of a young *serra*; but its contour is much more curved and elongated. Although smooth to the eye, its hinder surface, under the glass, exhibits faint radiating striolæ towards the ventral margin. I suspect that in a younger stage the marked radiating striæ upon the blunt umbonal ridge are not developed.

DONAX LISTERI, n. sp. (Plate XII. fig. 2.)

T. abbreviato-trigona, subinæquilateralis, sublævigata, intus purpurea, extus omnino albido-purpurascens, zonis saturatioribus remotis ornata, antice subventricosa (seu convexa), postice subcompressa; area postica rugis concentricis tenuibus, striisque numerosis inconspicuis arctis decussatim scabra. Margo dorsalis utrinque (præsertim postice) declivis et subrectus; margo ventralis haud crenatus. Dentes laterales satis manifesti.

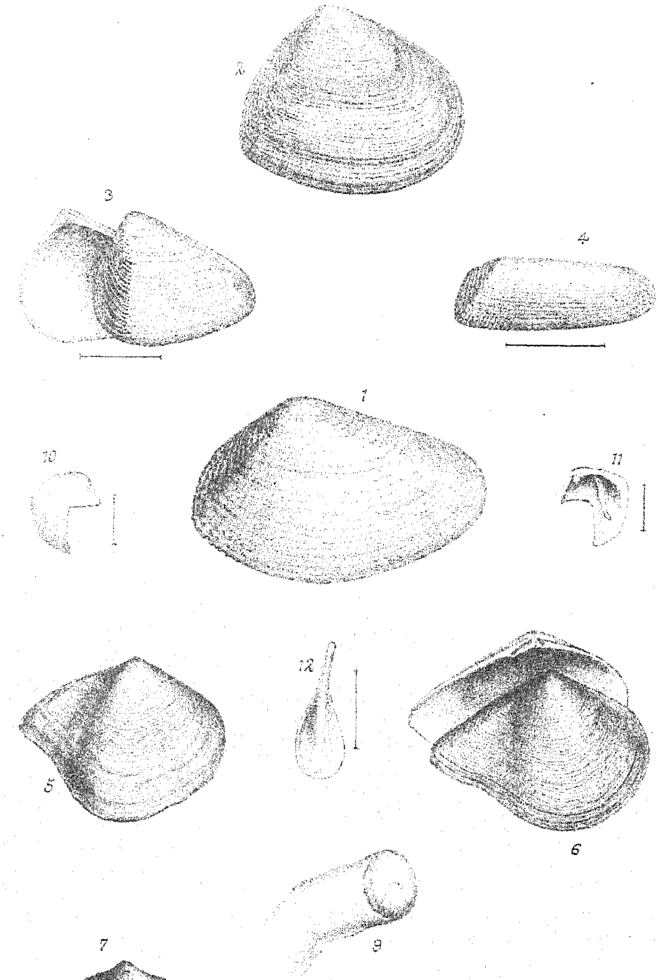
Long. 1·15, lat. 1 poll. *Hab.* —— ?

This rare shell, formerly in Belcher's collection, differs alike from, yet resembles, that figure in Lister (pl. 391. fig. 230) from which, and the words "extus intusque purpurascens," Gmelin fabricated his *Tellina purpurascens*, and from the *Donax compressus* of Lamarck:—from the former, which is also more equilateral, by its less cuneiform hinder termination; from the latter in being rounder and much higher from the beak to its opposite edge, and by being less peaked in front. I observe that the two shells are confounded in the more recent monographs, and the expressive and well-defined Lamarckian species is suppressed in favour of a name based upon a figure which does not even exhibit a hinge, so that its very genus is problematical: if a *Donax*, it is more like Reeve's figure of *deltoides*. The hinder sculpture in our unique specimen has a tendency to overlap the obtuse umbonal ridge near the ventral edge.

DONAX FLAVIDUS, n. sp. (Plate XII. fig. 3.)

T. subcordato-trigona, abbreviata, valde inæquilateralis, antice compressa et rotundato-acuminata, postice brevis et subventricosa; extus flavescens, intus albida, haud radiata, aut maculata, nitida, lævis, sed extremitatem posticam versus transversim sulcata seu plicata. Costa umbonalis nulla. Margo posticus convexus; margo ventralis postice subgibboso-arcuatus, intus subcrenulatus. Dentes laterales satis manifesti.

Long. 0·5, lat. 0·4 poll. *Hab.* Borneo (teste *Geale*.)



Borjeau lith.

Hanhart imp.

NEW SPECIES OF DONAX, & *Species of* LEPTOMYA *With Valves & Pallets of* TEREDO UTRICULUS.

Its aspect and general tint recall the half-forgotten *D. stramineus* of Gmelin, a shell fairly defined, from its combined figure and description, by Schröter. It does not display, however, the purple stain on the hinder slope, and widely differs in outline. The grooves are feebly decussated by minute radiating lines at the broader end (which is oblique, rounded below).

Darwin's figure of *Lepas crassa* conveys the impression of the general shape (except the posterior outline) of this very rare shell, of which I have never seen but one example.

DONAX IMPAR, n. sp. (Plate XII. fig. 4.)

Testa parva, maxime inæquilateralis, valde elongata, compresso-cylindracea, antice rotundato-acuminata, postice brevissima et abrupte truncata, candida, polita, omnino lævis, nisi ad aream posticam planam aut concavam, ubi concentrice est sulcata. Margo dorsalis anticus vix declivis; margo ventralis haud crenulatus.

Long. 0·7, lat. 0·2 poll. *Hab.* Beloochistan (*Blanford*).

The nearest approach to this remarkably elongated shell is *D. Owenii*; but the present is still more inequilateral. I possess only a single valve; but as it is in fine preservation, and as in the section *Machærodonax* both valves are alike, I venture to describe it; the colour, however, may vary.

In the plate I have added a few illustrations of species of *Leptomya* &c. hitherto unfigured.

DESCRIPTION OF PLATE XII.

Fig. 1. *Donax Mesodesmoides*, n. sp., nat. size.
Fig. 2. *D. Listeri*, n. sp., nat. size.
Fig. 3. *D. flavidus*, n. sp., enlarged.
Fig. 4. *D. impar*, n. sp., enlarged.
Fig. 5. *Leptomya gravida*, Hanley, nat. size.
Fig. 6. *L. psittacus*, Hanley, nat. size.
Fig. 7. *L. spectabilis*, slightly enlarged.
Fig. 8. *L. cochlearis*, Hinds, nat. size, from unfigured type in the British Museum.
Figs. 9 to 12. *Teredo uticulus*, Gmel., valves and pallets, the latter enlarged.

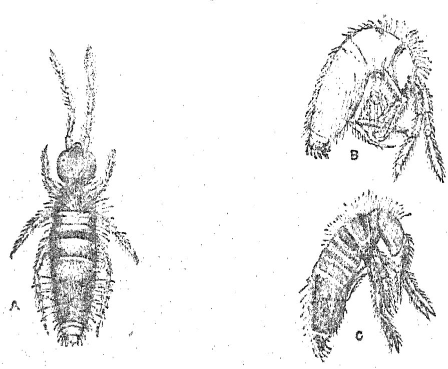
On a new Genus of Collembola (*Sinella*) allied to *Degeeria*, Nicolet. By GEORGE BROOK, F.L.S.

[Read June 15, 1882.]

THE genus *Degeeria* was founded by Nicolet, in 1842, for the reception of those species of the old Linnean genus *Podura* which have the antennæ shorter than the body, consisting of four subequal segments and a minute basal ring, abdomen tapering, with the fourth abdominal segment longer than the three preceding taken together. The specimens here described were collected

in December last, and, after a cursory examination with a pocket-lens, were labelled *Degeeria lanuginosa* (Nicolet), on account of the absence of markings and the very thick clothing of hairs, especially on the thorax. As I was engaged on a revision of Nicolet's genus, they were kept alive for further observation. It was soon found, however, that my specimens differed in several important points from Nicolet's species. Instead of having eight lenses in each eye-patch, I could only find two lenses on each side, and each on a separate patch. The structure of the claws and spring also presented characters which did not agree with the diagnosis of *Degeeria*. In the course of a few days faint fulvous patches began to appear on my specimens; and in a week more some of them were quite dark fulvous, with a few lighter dorsal patches. This colour is not distributed in more or less sharply defined spots and patches, as is usual in those species of *Degeeria* which have markings, but the general body-colour becomes a rich fulvous, darker laterally, and shading off to the median dorsal line. The specimens were also armed with a kind of curved clubbed setæ on the abdomen, quite different from the setæ of any species of *Degeeria* with which I am acquainted. For these reasons, and after a careful comparison with allied British species, I feel justified in proposing a new genus for the reception of these specimens.

Fig. 1.



Sinella curviseta, n. sp. A. Full-grown insect, showing distribution of colour-patches, × 16. B. Pale specimen, showing position of eye-patches, × 16. C. Dark specimen, showing patches of colour and shape of third abdominal segment, × 16. Drawn from enlarged photographs and specimens mounted on microscopic slide.

SINELLA, nov. gen.*

Head quite as broad as long, a little protruded between the antennæ. *Eyes* situated near the base of the antennæ, four in number, two on each side, each lens situated on a separate patch, the upper one rather larger than the lower and irregular in outline. *Antennæ* composed of four segments with a rudimentary fifth as in *Degeeria*: first longer than is usual in *Degeeria*, about one third the length of second; second usually a little longer than third; fourth about twice as long as third: proportional length of segments varies, however, a little in different individuals. *Prothorax* small, entirely hidden by the mesothorax above. *Mesothorax* large, narrower anteriorly. *Metathorax* shorter than the second. *First abdominal segment* quite small, difficult to see in some specimens, unless the insect is laid on its side. *Second abdominal segment* about three times as long as first. *Third abdominal segment* twice as long as second; below produced posteriorly under the fourth for half its length. *Fourth abdominal segment* nearly as long as the thorax and first three segments of the abdomen taken together, tapering slightly posteriorly. *Fifth and sixth abdominal segments* small. *Spring* always reaching the ventral tube, which in the living insect is usually clasped by the terminal segments. *Manubrium* about as long as the *dentes*, scarcely tapering. *Dentes* tapering, slightly crenate along the margin and corrugated across as in *Degeeria*; towards the extremity each of the dentes splits up into three parts, the outer two of which seem to form a sheath, ciliated along their margins; the inner one bears the mucrones. *Mucrones*, seen from above, almost straight; seen laterally, scimitar-shaped, consisting of two lobes. *Claws of first pair of legs*—*Large claw* curved, and bearing a large tooth about the centre of its inner margin, and two small ones between that and the tip; sometimes the small teeth are very indistinct, and only appear as an unevenness in the margin. *Lower claw* spathulate, about half as long as the upper one, and without teeth: there is no tenent hair properly so called; but its place is taken by a strong hair of the ordinary kind. *The head and thorax* are thickly covered with bristles, which are bent forwards on the head and outwards on the thorax; they get gradually thicker towards the tip, when they suddenly come to a point; finely ciliated along the margin. *Terminal segment of the abdomen* covered with short thick clubbed bristles, which are bent inwards and strongly ciliated.

It will be seen from the above description that the species here described, and for which I propose a new genus, differs from all other described species of Collembola, the *Isotoma quadrioculata* of Tullberg excepted, in having two eye-patches on each side. From the genus *Degeeria* of Nicolet, to which perhaps it is nearest allied, it differs in the following points:—

* I have named the genus after Mr. J. Sinel of Jersey, who has been very assiduous in the collection of specimens of Collembola for me.

1. In the number of eyes, which in *Degeeria* are 8 in each group.

2. In the absence of a true tenent hair on each foot.

3. In the almost total absence of those long fine abdominal hairs set at right angles to the body so characteristic of *Degeeria* and *Orchesella*.

4. In the possession of a thick covering of strong, thickly ciliate, clubbed hairs on the sixth abdominal segment, unlike any hairs of this group with which I am acquainted.

5. In the rather different construction of the mucrones.

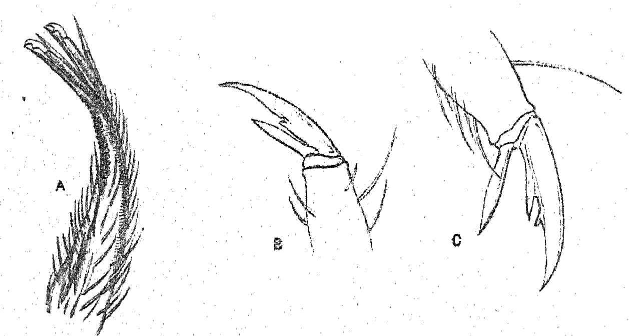
From *Isotoma* of course it differs in the general shape of the body, but agrees with it in the absence of tenent hairs. From *Sira* it differs in the absence of scales, and also in those points mentioned under *Degeeria*. From *Corynothrix* of Tullberg this genus differs in the proportional length of the abdominal segments, as well as in the points mentioned under *Degeeria*.

SINELLA CURVISETA, n. sp.

The species described was found under boards in a vinery at Huddersfield* in December 1881, and has been kept in confinement since that time (six months). Young and immature though in some cases full-grown specimens are of a uniform pale yellow colour, paler on the spring and legs.

Such specimens might easily be taken at a glance for *Degeeria lanuginosa* of Nicolet.

Fig. 2.



S. curviseta. A. Lateral view of mucrones, × 200. B. Claws of third pair of legs, × 200. C. Claws of first pair of legs, × 200. From enlarged photographs and mounted specimens.

* Since the above was in print I have received a specimen of this species from Miss Garrod, who found it in a similar locality in London.

Darker intermediate forms occur, more or less spotted and patched with a fulvous brown. The type is of a uniform fulvous brown colour, excepting the central portion of the posterior part of the mesothorax and the metathorax, and the upper central portion of the first abdominal segment. The third segment of the antennæ is often fulvous.

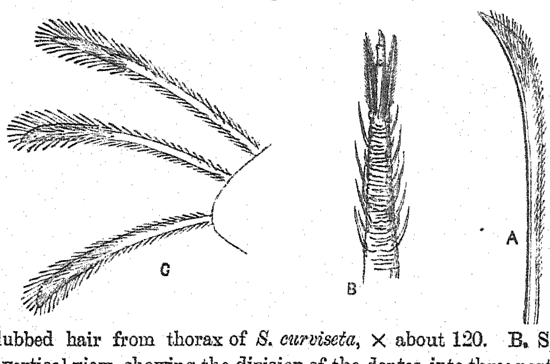
The following are a series of approximate measurements of a full-grown individual:—

	inch.		inch.
Length of body..........	$\frac{1}{16}$	Length of spring	$\frac{1}{30}$
,, abdom. & thorax	$\frac{1}{21}$	Width of 3rd abdom. segm.	$\frac{1}{58}$
,, head..........	$\frac{1}{78}$	,, head	$\frac{1}{75}$
,, antennæ	$\frac{1}{35}$		

This species is rather active, and seems to live well in confinement. Eggs were laid early in January, apparently singly. They were spherical, white, and not very shining, faintly and widely wrinkled. A depression with a raised rim round it occurs at both ends, as figured by Nicolet.

On January 23rd a young, apparently recently hatched individual was observed. The head was large and slightly broader than the thorax. Antennæ large, with first three segments subglobular; fourth joint thick and fusiform, nearly as long as the other three together. Spring reaching the ventral tube. Colour white, with two distinct eye-spots on each side.

Fig. 3.



A. Clubbed hair from thorax of *S. curviseta*, × about 120. B. Spring of *Sinella*, vertical view, showing the division of the dentes into three parts, one of which bears the mucrones, × 200. C. Clubbed hairs from sixth abdominal segment of *Sinella*, × about 150; these are usually bent under the abdomen. From enlarged photographs and mounted specimens.

On some Cutaneous Nerve-terminations in Mammals. By Dr. George Hoggan, and Dr. Frances Elizabeth Hoggan. (Communicated by Dr. James Murie, F.L.S.)

[Read June 1, 1882.]

(Plates XIII.–XVI.)

Contents :—Introductory remarks on the "organ of Eimer" in the Mole. Habits shown by a Mole in confinement. Nerve-distribution upon hairs. Medullated nerves passing to hairs. Nerves terminating in branched cells on hairs. Forked nerve-terminations on hairs. Development of nerve-terminations on hairs. Jobert's coil of nerve-fibrils surrounding follicle. Intraepithelial nerve-fibrils of outer root-sheath. Structure of organ of Eimer in the Mole :—Inner circle of nerve-fibrils; the ganglion-cells ; outer circle of nerve-fibres. The organ of Eimer a retrograded hair-follicle. Effect of habit in causing evolution of the organ of Eimer. The tail of the Mole as a special tactile organ. Ranvier's hypothesis of direction of growth in nerves. Merkel's hypothesis of different functions of cutaneous nerves. Ranvier's objection to Merkel's views. Our proofs that nerve-cells and intraepidermic nerves are continuous. Origin of the cells of Langerhans. Have the intraepidermic nerves any function? Professor Ranvier's hypothesis negatived. Subepidermic plexus of nerve-cells and fibres. Concluding remarks on the organ of Eimer.

Introductory Remarks on the Organ of Eimer in the Mole.

A considerable portion of the present paper was prepared for this Society at the beginning of the present year (1882) under the heading "The Nerve-terminations in the Insectivora as modified by their habits;" but a short time afterwards we found that part of what we had supposed to be discoveries of our own had already been published by others, and notably by Arnstein* and Bonnet†. It became necessary therefore to recast the whole; and if we could not present much that was original in discovery, we could at least, under the present title, give many deductions and amendments connected with facts discovered that are new in themselves, and opposed to many hypotheses held at the present day.

Taking as our text that beautiful and unique arrangement of nerve-terminations in the snout of the Mole, which has been called, after its discoverer, the organ of Eimer (figs. 1 & 2, Plate XIII.), we shall endeavour to analyze its component elements, and, in giving the history or description of each, to warrant our assumption of the title prefixed to this article. We shall also

* Sitzungsberichte der k.-k. Akad. Wien, 1878, Abth. 3.

† Morphologisches Jahrbuch, 1878, vol. IV. p. 329. A full list of the literature consulted will be found at the end of this paper, page 592.

point out the share which the habits of the animal have had in forming so apparently unique an organ out of elements existing plentifully in every mammal, and show that, in short, it is merely formed by a combination of the invariable intraepithelial nerves of the locality, common to all the Mammalia, with the nerve-endings belonging to the hairs or whiskers. These latter, by the peculiar digging movements of the Moles, have so often been torn out that finally the hairs have become entirely suppressed, although the arrangements of the nerve-terminations upon their follicle remain behind; and these, modified in appearance by the absence of the hair, now go to form what is known as the "organ of Eimer."

In the original article in which Eimer* announced his discovery of that organ, he states that if a live Mole be confined in a vessel, it soon shows, by the manner in which it feels all over the walls of its prison with its proboscis, that that structure must possess the sense of touch in a high degree; and it seems to have been this behaviour on the part of the Mole which induced Eimer to search for and discover its peculiar nerve-apparatus. He also enlarges upon the special anatomical richness of the snout in such nerve-organs, which he enumerates as amounting to 5000; and he holds that, physiologically, the sensitiveness is demonstrated by the fact that a smart tap on the nose kills the animal. Let us, however, remark in passing, that if all the hairs were plucked out of any particular part of this animal's or of any other animal's body, and the shrinking together which this would entail in the part operated upon be taken into consideration, the nerve-supply would appear to be equally plentiful with what is seen upon the Mole's proboscis. Thus Eimer has somewhat exaggerated the anatomical importance of the part, in nerves, just as he has magnified its physiological importance, as those who know the extreme sensitiveness of the smaller Shrews to impressions even upon their tails, may easily conceive. It was similar watching of the habits of Rats which led Jobert to look for tactile hairs on the tails of those animals, and to prove to his own satisfaction that the existence of such hairs (8552 in number, according to his enumeration) rendered the tail a tactile organ. He also thought that he settled the matter completely by cutting off a Rat's tail and finding that thereby its agility was impaired—the fact, however, being that what

* "Die Schnauze des Maulwurfs als Tastwerkzeug," Archiv für mikroskopische Anatomie, 1871, vol. vii. p. 181.

he thought were tactile nerve-endings are now known not to be nerve-endings, and that the hairs upon all the rest of the surface of the animal's body are now proved to be provided with nerve-terminations equally (if not more so) with the hairs of the tail.

It was from the result of similar watching of the movements of a pet Mole that we, in entire ignorance of Jobert's researches, were led to look upon its tail as a tactile organ, and to discover, as we thought at the time, the real tactile nerve-terminations upon the hairs of the tail. There are still good reasons for holding that in the Mole the tail is specially a tactile organ, in comparison with the tail in other animals; and as the appearances which led us to make the research are interesting in themselves, as well as explanatory, if not even contradictory, of much which now passes current as the habits of the animal, it may be advisable that we should relate them here.

Habits shown by a Mole in Confinement.

Our pet Mole, "Jimmy," was presented to us by our friend Mr. Betts, of King's Langley, who caught it on the surface of the ground in one of his fields. Shortly after capture it greedily took worms even from our fingers, without manifesting the slightest shyness or appearance of fear. With the intention to watch its habits, we afterwards placed it for safety in a large cage or box (in our garden laboratory, in London), made of strong boards or planks an inch in thickness, which in previous years had successfully withstood the gnawing of innumerable generations of tame rats. The box was placed upon its side, and had a sleeping-compartment at one end. The front was covered with a piece of strong small meshed wire netting.

The sleeping-compartment was filled with earth, an act of forethought the Mole seemed fully to appreciate. During the day it would often feel all over the wire netting with its proboscis, but whether in search of liberty or food was never quite certain; probably it began with the desire of liberty and ended with that of food, which latter was generally given it through the netting. We fed it with earth-worms, a morsel of meat, or part of a mouse. If a very small piece, it would eat it on the spot and seek for more; but if the morsel was large, it would carry it off to the darker corner, there to devour it at leisure. We observed that, although the spot where the Mole received the morsel was quite two feet distant from the inner chamber, it never turned to run back

as would a rat, mouse, or other animal; but, instead, it always walked straight backwards, as easily apparently as it progressed forwards, though there was ample free space for it to turn round. Even when frightened, or on other occasions, progress backwards was manifest; hence we conclude this to be a habit acquired through living in long narrow subterranean burrows or tunnels, and being thus cramped for turning. Doubtless this habit has become so thoroughly ingrained into the animal and race, that even in localities with abundance of space to turn in, it is still clung to. When moving backwards, we constantly observed that it kept its little short tail close to the floor of its cage, moving it about from side to side as if feeling the way for the body to follow; and it was this peculiar action which led us to look for histological evidence of the tail being a tactile organ.

Having placed the creature in a large earthernware footbath one third full of earth, it continually burrowed; and, as it dived down, its short tail kept wagging from side to side in the upright position, as if it were a guide directing the line of burrow. Indeed, placed between the tactile apparatus on the nose and on the tail, the body of the little sapper seems to be to him both level and compass to guide him in the laying-out of his subterranean passages.

The following account of habits is frequently recited by authors: —"Occasionally a Mole will form two or more high roads leading to his fortress; and sometimes several Moles share the same highway, perhaps in localities where worms and grubs are peculiarly fat and abundant. But in the latter case, as there is not room in the little tunnel for one Mole to pass another, if two of them meet by accident, one of them must give way, or retire into a side alley; otherwise a violent combat ensues, when the weaker is ruthlessly killed and devoured." Now what human eye ever saw two Moles, inmates of the same burrow, meet underground, or watched the violent combat and cannibal feast so graphically described? The fact is, that it is as easy for the weaker Mole to walk backward as for his opponent to walk forward, and thus to avoid all necessity for a combat.

The oft-quoted statement (Bell's 'British Quadrupeds,' and elsewhere) of the great speed of the Mole seems to rest upon one of M. Henri Le Court's hyperingenious experiments. A number of pieces of straw were lightly let down into the burrow at different points, so as to occupy the centre of its lumen. On the

outer end of each straw a small paper flag was so placed that it would inevitably fall when the lower end was touched. When all was ready, the experimenter blew a fearful blast through a trumpet at one end of the burrow, the Mole being at the other; and as, one after another, the flags fell almost simultaneously, this was supposed to be due to the passage of the frightened animal towards its fortress at a rate of speed equal to a horse going at full trot. Less sanguine minds may, however, only attribute the falling of the flags to the blast of air from the trumpet, or to the vibration in the air due to the same cause, and acting with great force in the narrow channel. At all events, it is simply ridiculous to compare the speed of a Mole in his burrow to that of a horse at full trot.

The conformation of the fore feet, even if the observer had never seen a Mole try to run away, would in itself show that they were not adapted for speed; in fact, every thing in them is adapted for digging, and for nothing else. Their efficacy was shown by our Mole thus:—It began in the corner of its home (the last locality Rodents would attack; for they always choose projecting localities for gnawing), just where the three boards or planes met at right angles to each other and furnished it with a *point d'appui* for its peculiarly adjusted hands. In less than two hours it had scraped a hole right through the inch-thick boards. The nails seemed to act like a coarse rasp in making fragments of wood fly off; and so eagerly did it work that it resisted viciously when we attempted to pull it away; and when released, it rushed back to the spot, and began anew, rasping with desperate eagerness.

According to our observations, the Mole uses its fore paws for holding its prey while it is being devoured; but their merely digging-adaptation renders their action during feeding rather awkward. When given a worm, this was always held between the backs of the hands or, rather, thumbs; and, beginning at one end, the worm was passed into the mouth by a series of hitches of the fore paws, until devoured. On examining the backs of those paws for nerve-endings, we could only find the endings of nerves on the short tactile hairs with which the back of the hand was studded. These short bristly stumps, while they gave an exquisite sense of touch, were probably better adapted for holding the slippery worms than a naked epidermis would have been.

The sense of hearing is supposed to be very keen in the Mole,

to make up for the want of sight; but little dependence ought to be placed on such a statement until it be verified by histological investigation of the organ. Our experience would lead us to the opposite conclusion. Our Mole generally took a siesta of two or three hours in the afternoon, sleeping curled up into a ball, with its snout and head between the fore paws and under the body. When in this condition considerable noise did not disturb it. When, however, it did awake, it was with a great start, like one awakening out of a deep sleep and failing to recollect where he was. Moreover we know that rustics often approach Moles when they are shovelling the earth out of their burrows, and are able to kick the animal out of the mound before their approach is detected—a feat which a quick or even ordinary sense of hearing ought to render impossible. Their cantankerousness of temper is shown by their readiness to fight and eat each other; and it is this character, in conjunction with their stupidity, which causes them to be caught in the simplest of traps. Their anger is evidently aroused at finding their underground passage barred by a rough piece of iron; this they at once assault, and, pushing it away, allow the iron jaws of the trap to close upon them. One night our Mole made its escape and passed down through the floor of the laboratory, so that when we entered in the morning we could hear our pet digging under our feet. Finally it drove a tunnel under the brick lintel of the doorway, and thus provided for its retreat into the garden. Before, however, it could make this strategic movement, we placed an ordinary mouse-cage or box open near the hole, thinking thus to secure the creature. When it again came to the hole of exit it appeared greatly enraged at finding the box obstructing its path; and, not satisfied with merely pushing it aside, it shoved the hated box much further away than there was any necessity for: so much does passion blind a Mole's senses. This headstrong display cost it its liberty; while its furious temper by no means improved on capture.

It was amazingly fond of milk; and when a saucerful was given, it would plunge its head right into the milk, ending generally by rolling the whole body into it with as much earth as it could drag along. It finally died, we suspect, from inanition; for although we furnished it with food amply sufficient for any other animal of its size, this appeared insufficient for the ravenous appetite of the Mole. The tissues of its body wer afterwards prepared with

chloride of gold for microscopical observations, and served for the basis of this paper.

After, as we thought, discovering the various kinds of nerve-terminations upon the hairs on the tail of the Mole, and studying the character of the intraepithelial nerve-fibrils in the "organ of Eimer" and other parts of the hairless portions of the surface of the animal, we, naturally enough, extended our research to the bodies of other members of the Insectivora, such as the Shrew and Hedgehog, in the hope of finding some analogy in them with the organ of Eimer and other nerve-terminations, especially in the noses of these animals. Finally we extended our observation to a large number of other animals of different classes, such as Man, the Mouse, Rat, Rabbit, Guinea-pig, Sheep, Pig, Goat, Bullock, Cat, and Horse; and this has enabled us to arrive at general conclusions which would have passed unnoticed had we confined our observation to the one class of the Insectivora. In this research, therefore, we shall treat the question in a general way, taking each separate element as a whole, and afterwards pointing out modifications where they exist in different animals.

Nerve-Distribution upon Hairs.

There is a widely diffused popular and even scientific belief that in the lower animals one exceptional form of hairs, found on the whiskers, eyebrows, ear-tufts, elbows, &c., and spoken of generally as whiskers, feelers, or tactile hairs, alone possesses special tactile nerve-organs, and that they differ in this respect from the ordinary hairs of the rest of the body, which are alone represented in man. Within the last year or two, however, researches have been made which go far to show that even the minutest hairs upon the smallest, as upon the largest, mammals possess a more or less complicated nerve-supply; and it is now considered that as all the hairs on an animal's body are equally supplied by nerves of touch and of general sensation, the term tactile hair, as it applies to all hairs, should be henceforth disused. In lieu of the term tactile, it is proposed to use a term derived from a microscopically minute anatomical difference between feelers and ordinary hairs, which would be unintelligible to most people from its obscure character, and, having no evident bearing on physiological characters, would soon have to be replaced by a more suitable name. To us the term *feeler* seems, upon both

anatomical and physiological grounds, best fitted still to represent something different from ordinary hairs. If the observers who wished to make the existence or non-existence of a blood-sinus around the hair-follicle (*a*, fig. 13, Plate XIV.) the basis for a new name, had given their attention to the character of the muscles attached to those different hairs, they might probably have found reasons for letting the terms remain as at present understood. In the ordinary hairs the muscles which are attached to the base are of the smooth or involuntary type; and these, although they act upon the hair under the influence of temperature, moisture, electricity, &c., causing goose-skin and similar appearances, are yet completely beyond the control of the will. In the feelers, however, these muscles are of the striated or voluntary type, which gives the animal the power of moving the feelers at will in different directions, so that it may acquire by touch timely notice of the proximity of any neighbouring object. In this respect the feeler is a voluntary and active sensorial organ, while the ordinary hair is merely an involuntary and passive one; and for this reason we shall continue to use the term feeler in the sense hitherto accepted, as distinguishing it from ordinary hairs, bearing in mind also that this, like every other differential feature between hairs, passes insensibly into the opposite condition.

Of the other anatomical differences between feelers and ordinary hairs, or of the anatomical elements composing either, we intend to say as little as possible, where the question does not interfere with our present subject, which is a description of the nerve-arrangements on hairs. For the benefit, however, of our non-anatomical readers, we submit a short description of the hair-apparatus general enough to apply to all hairs. The hair-follicle is simply a depression in the skin, passing down like a well, whose sides are almost perpendicular to the outer surface of the skin. It is lined with layers of cells (*e*, fig. 13, Plate XIV.) similar to and continuous with those of the epidermis. Surrounding this epidermic lining we have a thin layer of specially clear gelatine, called the basement membrane (*b*, fig. 13, Plate XIV.), which is continuous with that of the surface of the skin, it being in turn surrounded by the general gelatinous tissue of the dermis, or skin proper. At the bottom of the follicle or well there may or may not be a papilla, covered also with epidermic cells; from this the hair itself grows, being formed solely of epidermic cells arranged in layers, and showing a great variety in appearance and substance in different animals

and in the same animal. A little way below the opening of the hair-follicle upon the skin, we have the opening into the follicle of a little sac or gland lined with cells (*s*, fig. 6, Plate XIII.), which secrete the grease of the skin. This sac is called the hair-gland or sebaceous gland. It is immediately underneath the level of the opening of this gland into the hair-follicle that the nerve-terminal apparatus is found. Finally, attached to the bottom of the hair-follicle, and passing somewhat obliqely towards the epidermis, we have the bundle of muscle-fibres which act upon the hair and gland *.

* Although not quite pertinent to our present paper, we wish to give a caution against merely considering the hair as a tactile organ, as it seems to have several functions to perform, although only one other, that of a covering, seems to be attributed to it in our physiological text-books. Some years ago, when teaching anatomy in Edinburgh, one of us was careful to inculcate upon our students those various uses of the hair and hair-apparatus, which we may here recapitulate. In the first place, the hair has a double function to perform on the great mass of the human skin, altogether apart from either being a covering or a tactile agent. It is a stylet, which keeps the mouth of the hair-follicle always clear for the comparatively inspissated material to flow from the sebaceous gland on pressure by the compressor muscles upon the surface of the skin; and at the same time it is a semicircular valve, similar to that known to marine engineers as a D valve, which occludes the mouth of the sebaceous gland when that gland is quiescent, preventing ingress of foreign matters into the gland; but when the compressor muscle contracts and compresses the gland, the same movement moves the hair valve from the mouth of the gland, leaving a space also between it and the hair-follicle, so as to permit egress to its sebaceous contents. According to this way of thinking, the gland is not an appendage of the hair, as is generally supposed, whence its name of hair-gland. It is an appendage of the skin; and the hair itself is only an appendix to the gland.

In the same way the so-called hair-muscle, the *erector* or *arrector pili*, we consider not to be an appendage of the hair, as its name implies, but an appendage of the sebaceous gland; and hence, ten years ago, we proposed to call it, and always called it, the *compressor glandulæ sebaceæ*, from its evident action of acting as the compressor of the sebaceous gland, and the excretor of its thick contents. That this muscle, on contracting, should cause goose-skin by depressing the skin at one of its extremities of attachment, and that it should cause the hair to protrude and lie at right angles to the surface at its other extremity of attachment, are merely accidental phenomena attendant upon the performance of its function, not the functions performed by the muscle, and ought, therefore, never to have given a name to the muscle. That the hair acts specially as a stylet, is seen also in the sebaceous glands or their analogues on certain moist surfaces of the body, which, from the fact of being moist, are never liable to become blocked up, and therefore the hair, being unnecessary as a stylet or valve, is not present.

Directing now our attention to the nerve-termination, our first proposition is, that as a principle (hitherto apparently overlooked) there is no difference in the character of the various nerve-elements supplied to all kinds of hairs, or in the respective position of these elements upon the hair-follicle, although the number, or even the shape, of the elements may vary considerably upon different hairs and between different categories of hairs, *e. g.* between feelers and ordinary hairs as they exist upon the same animal, but more especially as they exist in different classes of animals. Enumerating these nerve-elements in the order in which they come (from below upwards) on the follicle, we find :—

1st. The medullated nerve-fibres passing from the great nerve-centres towards the hairs.

2nd. These fibres, on reaching the hair, losing their myeline sheath of medulla, and ending :—

a. In branched ganglionic nerve-cells lying in the lower strata of epidermic cellular sheath lining the follicle.

b. In fork-shaped parallel fibrils, from one to four in number, parallel to the axis of the hair.

c. In a coil of non-medullated fibrils surrounding the fork-shaped terminations, and placed immediately underneath the opening of the sebaceous gland into the follicle.

3rd. Intraepithelial, non-medullated, but varicose nerve-fibrils ramifying among the epidermic cells lining the follicle.

The Medullated Nerves passing to Hairs.

Of the medullated nerve-fibres passing to the hairs, little need be said. They represent the main insulated telegraphic channels along which nervous influence or influences pass between the central nerve-centres in the brain and spinal cord and the nerve-terminations, or it may be, as we shall show, the peripheral nerve-centres on the hair-follicle. If, however, there be nervous influences of various kinds, such as the sense of touch, of temperature, &c., passing along separate nerve-fibres, there is no differentiation in the anatomical structure of these that allows them to be recognized as the carriers of the one or the other influence.

In the feelers the number of these nerves varies considerably according to the size of the hair; and we have counted between 300 and 400 nerves on several occasions on some of the

largest of these hairs in the Horse. They arrive on the feelers about the level of the lower extremity, and pass up alongside the follicle in bundles which become more numerous as they pass upwards. These bundles may either lie imbedded in the gelatinous tissue external (as regards the hair) to the basement-membrane, as at *d*, fig. 13, Plate XIV.; or they may pass through the cavity of the blood-sinus, as at *d**, in which case, whether it be a single nerve or a large number of them in a bundle, they are always surrounded by a thick coating of gelatine. In the ordinary hairs the nerves may be only one or two in number, which generally approach the hair at a much higher level than in the case of the feelers, and, it may be, from opposite sides of the hair. In the immediate neighbourhood of the hair each fibre may divide, and even subdivide, into two or more branches or independent fibres, each of which has its own special set of terminations, as seen at *a*, fig. 7, Plate XIII.

In these nerves the medulla or myeline is an insulating substance or sheath of the nature of fat, which is placed upon the axis-cylinder or true conducting nerve in segments of equal length, which bear the same relation to the axis-cylinder that long bugle beads bear to the thread upon which they are strung, each bugle-bead-like element being a complex cell resembling the fat-cell in character, and possessing protoplasmic walls, a centrally placed nucleus, and cell-contents of an oily character, which form the insulating substance. As seen in fig. 7, Plate XIII., when a nerve breaks up into two branches, the division always takes place at the end of one of the insulating segments, where the two new segments on the now bifurcated nerve or axis-cylinder are applied. Sometimes only one of the bifurcations is provided with a myeline-sheath, if near its termination, as at *i*, fig. 7, the other bifurcation breaking up into several non-medullated nerve-fibrils, as shown there. Or a nerve may lose its insulating sheath some distance before it breaks up into its ultimate termination, as seen at *k*, where the axis-cylinder may also be distinctly traced as it lies within its last insulating segment *.

* For more minute information respecting the medullated nerve-fibres, see our articles "Sur les changements subis par le système nerveux dans la lèpre" (Archives de Physiologie, 1882), and "De la dégénération et de la régénération du cylindre-axe" (Journal de l'Anatomie, 1882), copies of which are in the Society's library.

Nerves terminating in Branched Cells on Hairs.

This, the lowest in level upon the hair, and the first in order which we tabulated, is an ending which bears very different relations to the medullated nerves according to the character of the hair upon whose follicle they lie. In the first place, we may remark that, as far as we can learn, no observer except ourselves seems to have noticed that such branched cells may be seen on all the ordinary hairs, and that the latest, and, indeed, the only investigators of this question, namely Arnstein and Bonnet, in 1878, and Merkel, in 1880, not only make no allusion to them, but do not even show them in the drawings they give of nerve-terminations on ordinary hairs. It is true that there such nerve-cells have neither the number nor regularity which make them so prominent upon the feelers; but their existence can none the less be easily verified (*c*, figs. 6, 7, and 14). Indeed, when we thought we were discovering nerve-endings upon the ordinary hairs, these cells were the first objects to meet our eye.

The oversight already referred to may also be due to another special feature found on ordinary hairs. In some hundreds of specimens of such terminations on ordinary hairs which we possess, we have never yet come across an example where a medullated nerve passes directly to one of these cells, as seems to be the invariable rule in the case of the feelers. This may have led to their existence being unnoticed—an oversight otherwise inexplicable. In the feelers the connexion of the medullated nerves with these cells is very apparent; and it has been known under one description or another for the last ten years, although at the present day the most diverse opinions as to their true nature are held by all the observers who have specially investigated the subject. As far back as 1866 Odenius thought that the nerves terminated in an oval swelling; but his opinion is given with a certain amount of hesitation. Again, in 1872 Sertoli described the nerves as terminating, after piercing the basement-membrane, in stellate cells lying among the lower layers of epidermic cells lining the hair-follicles. The observations thus made by this author, although perhaps nearer the truth than any that have subsequently been made, have nevertheless been rejected by succeeding observers, none of whom apparently can agree in their conception of these endings.

Thus it is that we find Dietl, in 1873, describing the nerves as

ending in shield-like bodies in the outer root-sheath of the hair-follicle. Redkel, in 1873, describes them as pear-shaped clubs lying outside of the basement-membrane; Mojsisovics, in 1876, as oval and tactile cells in the outer root-sheath. Merkel, in 1876, describes them as oval and terminal tactile cells in the lower layer of cells of the epithelial lining of the hair-follicle. Bonnet, in 1878, speaks of them as end buds on the nerves after these pierce through the basement-membrane. Finally, Ranvier, in 1880, puts an entirely new interpretation upon the matter by denying that the nerves terminate in cells, and asserting that they are in connexion with tactile and terminal disks of nerve-matter, concavo-convex in shape, which are closely applied to the so-called terminal cells. A large number of these disks, he says, are found in connexion with the same nerve-fibres, all of them lying in the same direction and in the same relation to the tactile terminal cells which they embrace, thus forming an arborization having a certain elegance of form. Our figures 11 and 12 may be taken to represent Ranvier's views on this question, although we place a different interpretation upon these drawings. It is perfectly true that one part of the surface of the cell is stained by gold much darker than the rest, which seems to argue strongly in favour of Ranvier's theory of tactile disks upon tactile cells; and in this respect fig. 12 appears almost unanswerable. On closer examination, however, we find many peculiarities incompatible with his theory. In the first place, those blackened nerve-expansions are not, as he states, all concavo-convex disks, nor have they all the same direction (*orientation*), their concavity looking downwards. In our fig. 11, Pl. XIV., the cells *a a* have no disk at all, and appear as if they had been placed upon the blackened nerve-fibril in a very irregular manner. In the second place, the special blackening of one portion of the cell does not thereby prove that that portion only of the cell is nervous in character. In the same figure it is seen that the portion *c* of the nerve-fibril intervening between where the myeline ceases at *b* and the cells at *a*, is equally almost colourless; while the portion *d* further on amongst the terminal cells is stained jet-black; yet no one would for a moment argue that the portion *c* is less nervous in character than the portion *d*. The cause of the special blackening in one spot in gold preparation is as yet a puzzle to us, like numerous other peculiarities in the behaviour of this notoriously uncertain re-agent; but, from its irregular effects on many of our prepara-

tions, we are not inclined to found any special anatomical theory upon it, and therefore cannot accept Professor Ranvier's theory of "*disques tactiles et cellules du tact.*"

As mentioned, however, by Ranvier, the great mass of these cells lie in the same direction, the light-grey body of the cell with its nucleus generally visible, lying towards the root of the hair when seen from the front; but when looked at obliquely, as at fig. 10, Pl. XIV., the whole appears as an ordinary stellate nerve-cell, identical in shape with those seen in the anterior columns of the spinal cord, with which, in our opinion, they are physiologically and anatomically identical.

The manner in which the nerves reach the cells has been differently described by various observers, but best by Bonnet and Ranvier. It must be admitted also that no one description applies to the many different ways in which a nerve arrives at, or is distributed to, the cells. The side view given in our fig. 12 corresponds almost literally with the description given by Ranvier. The nerve there loses its myeline when about to traverse the basement-membrane. After piercing through it, it passes beyond the first range of cells of the epidermic lining of the follicle (not inserted in the drawing, lest they should interfere with the clearness), then curves downwards with a bend whose convexity lies next to and is parallel with the axis of the hair, until it returns to the said lower layer of cells on the surface of the basement-membrane, where it becomes attached to various of the nerve-cells, and through these to many other cells, with which they are connected by fibres. These other cells have not been inserted in the drawing, as they could only be seen by great alteration of the focus, and, if drawn, would have greatly confused the drawing. All of these cells do not lie close to the basement-membrane, like cell *b*, which corresponds to the lower layer of epidermic cells; for the nerve-cell *a* corresponds almost to the second layer; and when we come subsequently to speak of the cells of Langerhans (p. 584), we shall see that the nerve-cells we have been considering may break away from their attachments and become free amongst the epidermic cells lining the follicle.

The above description of the course and relations of a nerve at its termination or, shall we say, origin in nerve-cells, gives only an imperfect idea of the direction of the fibre or fibres after they have lost their myeline-sheath. In fig. 10 we give a front view of the ramifications; and it is there seen that the fibrils resulting

from the bifurcation of the axis-cylinder pass on a certain distance before becoming connected with the nerve-cells, fig. 11 being on a portion of the same plexus, drawn at a greatly increased magnifying-power. While, however, in these drawings one nerve seems to be in connexion with a large number of cells, *c c*, in other preparations from the same hair several nerves may be seen to be all in connexion with a very small group of cells. In short, we look upon the whole group of nerve-cells round these feelers as a peripheral ganglionic nerve-centre connected with many nerves which pass towards the central nerve-centres, and consider that sensory impressions cause an influence to be developed in these peripheral cells which is passed out from them as an electric current is generated and passed from an electric battery or telegraph-station.

It is difficult to account for the fact that while in the feelers we may have so many medullated nerves connected with the ganglion-cells upon the follicle, we have never yet observed a medullated nerve in connexion with any of the few cells (fig. 15) upon the ordinary hairs. This, we think, is due to the very great number and importance of the cells upon the feelers, where they lie closely aggregated to each other, and in connexion with the afferent nerve-fibres connected with them. Are those cells, however, either terminal or tactile in the sense that all observers have applied to them? We think not. They are certainly not terminal; for they are all connected with each other so as to form a nervous circle, from which, it is true, elements may be broken off, so far leaving two terminal points, as we shall afterwards show to be the case; but such terminations can only be looked upon as accidental; and it is even questionable whether in this condition they are still capable or not of performing functions. We look upon the forked terminations *f* as the true terminal organs of the nerves of touch upon the hair-follicles; and we think it unwarranted to speak of the cells we have been considering as specially tactile; for they are more probably temperature nerve-organs. We have never yet been able to trace any connexion between these cells and the forked endings of the medullated nerves on any kind of hair; but on more than one occasion we have found on ordinary hairs that these cells gave off branches peripherally, which became forked, as seen at *c*, fig. 7, Pl. XIII. A more telling example, however, is drawn in fig. 15, which appeared isolated from all medullated nerve-fibres which

might, by any illusion in focal depth, have given incorrectly to the cell *c* the appearance of being continuous with the forked fibre *f* peripherally. Both centrally and peripherally the same cell appears to be connected with very fine non-medullated fibrils having fine varicosities in their course. Whether the forked fibre *f* really terminated as shown in the drawing, is open to question; for the absence of staining beyond these free ends might make it appear that they ended there when possibly they were continued further on. On more than one occasion also we have observed that one of the very fine non-medullated nerve-fibrils connected with such cells passed into the circular coil of nerve-fibres *l*, fig. 7, and became incorporated with it. At other times, we have observed, in a longitudinal section parallel to and through the axis of the hair, that long intraepithelial non-medullated fibrils continuous with such cells were to be traced (as in fig. 17, *i f*) ramifying between the cells forming the epidermic lining of the follicle. The important bearing that their position there has upon the whole question of intraepithelial or intraepidermic nerves will be considered (p. 586) when we specially consider that system of fibres.

Moreover, in innumerable cases, as in fig. 7, nerve-fibrils could be seen passing out peripherally from these cells, parallel to the forked terminations on the medullated nerves, and generally with their own terminations concealed by the forks amongst which they lay.

Finally, in transverse sections of either feelers or ordinary hairs, as in fig. 13, Pl. XIV., nerve-fibrils, continuous with the ganglionic nerve-cells, could be seen passing from these cells towards the free surface of the follicle. The importance of this arrangement will appear hereafter when we come to consider the intraepidermic nerves in general. We may also note the fact that, in transverse sections of hair-follicles, Eberth observed many years ago the presence of the branched cells of Langerhans among the cells forming the epidermic lining of the follicle. These are, no doubt, originally the ganglionic nerve-cells which have become entangled in the epidermis and broken off from the plexus, as will found further explained in the chapter on the cells of Langerhans.

Forked Nerve-terminations on Hairs.

While the swollen or cellular terminations just considered have for at least ten years been known to science under some descrip-

tion or other, the forked terminations, or, as Bonnet terms them, "lancet-shaped" endings (a name suitable only for those found in a few animals, such, for example, as the Horse, but not applicable to the Cat, Mole, or Shrew, as shown in figs. 3, 6, and 14), have only been known since 1878, when Arnstein discovered them. These are by far the most prominent nerve-elements upon the ordinary hair-follicles. In the large feelers it is difficult to detect them, while in the smaller feelers, as shown by Bonnet, they form a regular tier of short, broadened-out, spade-like forms, immediately beyond the end buds, as he calls the cells already described. A glance at our drawings figs. 3, 4, 5, 6, 7, and 15 will make one understand better than any description the character of these forked terminations. The medullated nerves *m*, on reaching the zone beneath the opening of the sebaceous gland *s*, fig. 6, into the hair-follicle, lose their medulla or myeline; and each axis-cylinder generally breaks up at once into from two to five branches, often remaining as one branch; at all events the branches lie parallel to each other and to the axis of the hair between the lower layer of epidermic cells lining the follicle and the basement-membrane. As a rule, the medullated nerves only break up into the forked endings when beyond the zone of the cell-termination, although in the ordinary hairs the cells are sometimes observed lying even beyond the points of bifurcation. The forked terminations are, as a rule, flattened; and the flat surfaces lie against the inner surface of the basement-membrane and the contiguous surface of the epidermic lining of the follicle. At times the free endings of the forks swell out into hoof-like terminations, as shown at *g*, fig. 7, Pl. XIII., from the Horse; at other times the points flatten out, as shown at *f*, fig. 6, from the Water-Shrew; so that these points may be described as being parallel, lancet-shaped, hoof-shaped, circular or club-shaped, the cause of such variations in shape being to us unknown and probably unimportant.

We have, as already mentioned, never been able to detect any connexion between the forks on the medullated nerves and the ganglion-cells, on the one hand, or with the coil of non-medullated fibrils which surround them, on the other. They evidently subserve a nervous function different from that of those belonging to the other elements; and we think that in all probability that function is the sense or touch, which hitherto all the later observers have attributed to the ganglion-cells we have described. This

much may, however, be said, that the forked endings are true terminations *, which cannot be said of either the nerve-cells or the various categories of non-medullated fibrils in coils or intra-epidermic ramifications.

While, however, we are inclined to look upon the forked endings on hairs as the true terminations of tactile nerves, there is one argument against this view, which it is only fair to state here. It is this, that in the feelers (the hairs which are supposed to be *par excellence* the tactile nerves) the system of forked endings is, comparatively speaking, poorly developed, while the system of ganglionic cells is even hugely represented.

Unfortunately, we human beings can form no conception of the kind of impression received by the lower animals when their feelers come into contact with any object; but if we were to admit that these hairs only give the feeling of touch pure and simple, as we feel it in our ordinary hairs, and, further, that the predominant nerve-element found there must be the one which conveys the sense of touch, then assuredly the cellular terminations would be the elements.

Still, however, holding, as we do, that our own perceptions of the sense of touch, as experienced in ordinary hairs, is a much safer criterion to go by than any hypothetical conception of what may happen in the feelers of the lower animals, we hold that the elements which predominate in our ordinary hairs—that is to say, the forked nerve-endings—have the greatest reason to be considered the tactile terminations of the nerves.

Development of Nerve-terminations on Hairs.

Hitherto little appears to have been made out of the manner in which the various nerve-terminations make their appearance upon the hair-follicles; and our own efforts in this direction have not been very successful. In the case of the forked endings, we have not yet been able to distinguish them at a period prior to birth. In figs 4 and 5 we give examples of the largest and smallest hairs we could find on the nose of a newly-born kitten. In both cases, however, the nerve-fibrils were so exceedingly fine that they

* We now consider that these forked endings are homologous with the terminal fibre in Pacinian bodies, with the club-shaped nerve-endings in the touch-bodies in the fingers and toes of Man and other animals, and with the flattened plates in the touch-bodies of Grandry in Birds. Our researches in this respect will shortly be ready for publication.

appeared to have length without breadth; and to make them evident we have given them more body and distinctness than they appeared to possess in the original. They form fit objects for comparison with fig. 7, an ordinary hair nerve-apparatus from the nose of an adult Horse, all of them having been drawn under the same magnifying-power. In connexion also with the identity which we shall draw between the forked terminations on hairs and the inner circle of fibrils in the organ of Eimer (fig. 1, *if*), this developing nerve-apparatus of the hair is most instructive.

In the feeler-hairs the ganglion-cells (figs. 11 and 12) appear to have reached their permanent position at birth; but in one case, in the Rabbit, we were able to see them in a half-grown fœtus lying at the bottom of the hair-follicle in masses. The course of development of both kinds of end organs may also be considered well illustrated in our fig. 9, from the lower lip of the Water-Shrew. The nerve-apparatus shown there belongs to what may be called an aborted feeler-hair, or feeler in course of development, being in a condition midway between feelers and ordinary hairs, and showing the two kinds of nerve-terminal organs in their simplest form.

In that feeler the forked terminations *f* are as yet stunted and lying in the same zone as, or even upon a lower level than, that of the ganglion-cells. These cells amount as yet only to one cell, *c*, upon each of the two bifurcations on each nerve.

If development had proceeded further, as it was likely to do, other cells would probably have become developed on each nerve-bifurcation, until a number similar to that seen in fig. 11 were seen there. The forked terminations would also probably have passed further on, so as to occupy the upper instead of the lower border of the swelling on the hair-follicle. This growth would probably take place by direct growth of the axis-cylinder peripherally, and the interposition of an additional myeline-segment between two of the existing segments*.

Jobert's Coil of Nerve-fibrils surrounding Follicle.

This arrangement of nerve-fibrils (seen at *j*, figs. 4, 5, and 7, Plate XIII.) appears to have been the form in which nerves were first perceived upon hairs, and was first described by Jobert, who observed it on the fine hairs, almost microscopic in size, that are found on the tails of albino Rats. He imagined that that was the only part of the body in which such terminations were found, as

* See our two articles referred to on p. 536.

we long afterwards made a similar mistake in the case of the Mole. To these nerve-coils he attributed the sense of touch, and proved the matter to be beyond doubt by the experiment of cutting off the tails of Rats, and ascertaining that they did not move about afterwards with the same agility. Subsequent investigation, however, has shown that such a ring exists upon the hairs all over the body, and that there is no reason for supposing that it has any thing to do with the sense of touch. What the function of this coil of fibres surrounding the hair-follicle may be is as yet undetermined. At intervals along the fibres fusiform nuclei or cells show themselves, exactly as they are seen on the fibres of Remak or of the sympathetic nerve-system. As already mentioned, we have been able to trace a connexion between the nerve-cells already described and the fibres in the coil, whose relation to the follicle and the cells seems to reproduce the relationship of the wire-coil to the coupled cells in the modern electric battery.

At other times special nerves join the coil, independently of either the cells or medullated nerves coming from the lower part of the hair-follicle. These nerves generally approach it horizontally from the side, instead of lying in the same bundles with the nerves going to the cells and forks. This coil surrounds the hair-follicle immediately external to the terminal points of the forked nerve-endings, lying between them and the basement-membrane, within which, however, some of its outermost (as regards the hair) fibres lie embedded. It occupies the zone immediately underneath the opening of the sebaceous gland into the hair-follicle, and is therefore the most superficial of all the nerve-structures lying upon the follicle. It seems to represent, as far as the follicle is concerned, the plexus of non-medullated nerves *n*, fig. 28, Plate XVI., which lies immediately underneath the epidermis on the general surface of the body, of which plexus the branches constitute the intraepidermic fibrils, which, as we have already seen and shall again notice, are also represented in the epithelial lining of the hair-follicle, *i f*, fig. 17, Plate XIV. Strange to say, Arnstein, who, in 1878, discovered the forked terminations on the hair-follicle, denied the existence of the coil, thus showing the necessity of examining many specimens before passing an opinion upon the whole. It is true that in nearly one half of the specimens, where the forked terminations are visible, neither the coil nor the nerve-cells can be seen; but that is merely because the gold method has failed to show them.

Intraepithelial Nerve-fibrils of Outer Root-sheath.

These nerve-fibrils, as we have just remarked, are homologous with the intraepidermic nerve-fibrils found on the general surface of the body, but more especially on those parts where the epidermis is thick and most quickly renewed, and upon which the desire to touch is concentrated, as, for example, in the noses of most mammals and the pulp of the fingers and toes in man (see figs. 18 & 25). In the hair-follicle they are connected inferiorly with the nerve-cells and circular coil of fibres, and superiorly or, rather, superficially with the subepidermic plexus of non-medullated nerve-fibres. In many cases, indeed, they are seen to be in direct communication with the intraepidermic fibrils proceeding from that plexus, more especially when such an intraepidermic fibril proceeds from the dermic papilla next to the hair-follicle, in which case the intraepidermic fibrils, after passing from the papilla almost perpendicularly to the plane of the epidermis, suddenly make a turn at the edge of the follicle, and, reversing completely their former direction, pass downwards in the plane of the epidermic sheath lining the hair-follicle (as seen in *if*, fig. 17, Plate XIV.), there to join one or more of the nerve-cells lying upon the hair-follicle. In one important respect, however, the intraepithelial nerve-fibrils seen within the epidermic lining of the follicle differ from the intraepidermic fibrils within the epidermis on the contiguous surface of the skin, inasmuch as, while the latter as a rule pass directly through the epidermis at right angles to the plane of its surface, the former ramify in a direction parallel to the surface of the epidermic lining of the hair-follicle. The cause of this difference we shall afterwards explain at greater length (see page 587); but we may shortly explain here that, in opposition to all those who have hitherto written on the subject, we consider the direction of growth of such fibrils to be lateral—that is to say, parallel to the surface of the body. Moreover we believe their presence in epidermis to be abnormal, and due to mechanical causes hereafter to be explained. Once, however, they are entangled in the epidermis, they are subjected to the conditions of growth of that epidermis. If constant wear and consequently rapid development of the epidermis is going on, the fibres are dragged rapidly towards the free surface, as is seen to be the case in the free epidermic surfaces of the body, where the fibrils appear almost always at right angles to the plane of the surface.

In the epidermic lining of the hair-follicle there is scarcely any

wear of the protected free surface, and consequently the intra-epithelial fibrils are allowed to follow their normal direction of growth, which is one parallel to the surface. The same fibrils seen in fig. 17, *if*, Plate XIV., from an ordinary hair-follicle cut longitudinally, are represented in a feeler cut transversely in fig. 13. The direction of those fibrils, however, although appearing perpendicular, is really parallel to the surface; and we were compelled to alter the focus of the instrument very considerably in order to draw their outlines. By using, however, a binocular microscope, it was seen that, after passing the first layer of cells, the direction of the fibrils, which were clearly in connexion with the terminal (?) ganglion-cells, was parallel to the axis of the hair and of the free surface of the follicle.

Having now briefly described the nerve-structures found upon the hair-follicles, in the order in which we previously enumerated them, let us now proceed to consider how far such structures are represented in the organ of Eimer on the snout of the Mole, or, rather, to reverse the problem, and show that the nerve-elements in the organ of Eimer are only the representatives or remains of nerve-elements usually found in hairs.

Structure of the Organ of Eimer in the Mole.

In order to understand the nerve-arrangements composing this organ, we must examine specimens showing it both in transverse and in perpendicular section. When examined in transverse section, it appears as if formed of circular groups of non-medullated nerve-fibrils, each group being about the same size and having the same arrangement in its component elements, although these elements may vary somewhat in numbers, as seen in fig. 2, Plate XIII. Each circular group is only about half the size of a hair follicle cut in transverse section; and they are removed from each other by a distance equal to about that of their diameter. The fibrils belonging to each group may be divided as follows into three groups:—

1. An outer circle, containing from 15 to 20 fibrils;
2. An inner circle, containing from 10 to 15 fibrils;
3. A central group, composed of from 1 to 3 fibrils.

Inner Circle of Fibrils.—When seen in perpendicular section, it is the inner circle of fibrils which constitutes the most prominent object of the group; and they are seen to form a cylindrical column, generally more or less constricted in the centre, as shown in fig. 1, Plate XIII., although in rare instances the cylinder appears

parallel throughout. In such sections it is difficult to distinguish the central group of fibrils, as they lie parallel with the others and can only be differentiated from them by careful focusing of the microscope. This is necessary also in examining the individual fibres formed by the inner circle, where the focus must be altered to the depth of the diameter of the column under a high power. For the same reason, in drawing these fibres it is necessary to limit them to those forming one half of the circle, as shown in our fig. 1, Plate XIII.; otherwise they would appear so closely packed and mixed up together, that it would be impossible to distinguish the individual fibres in the drawing. Careful examination of the fibres of the inner circle show that they lie outside of a cylinder or column of epidermic cells, as shown in fig. 8, Plate XIII., which is a drawing of a transverse section of the organ at the level of the lower surface of the epidermis. These epidermic cells are built up with great regularity; and at the intervals between the cells each fibril shows a swelling at the same level (see fig. 2); and this swelling, although only slightly marked at the lower portion of the fibril or organ, becomes developed into distinct buds connected by a short pedicle to the fibril as the latter approaches the free surface; and as these buds lie all at the same level, they give a striated appearance to the inner circle or column of fibres when seen under a low power. On reaching the corneal layer of the free surface of the epidermis, the fibrils break into small portions, each containing a bud, which, when it reaches the free surface, is thrown off like the superficial cells of the epidermis. Upon this peculiarity an important hypothesis has been developed by Professor Ranvier, to which we shall afterwards call attention (pp. 576 and 586), for the purpose of showing its inapplicability. Between these fibrils and those belonging to the outer circle there is a peculiar distinction of great value in deciding their real character, which has not only passed unnoticed hitherto by previous observers, but has not even been drawn in any of the numerous drawings hitherto published. That peculiarity consists in the fact that at the lower portion of the organ the inner fibrils have a considerable thickness, and that each fibre tapers off to a mere line as it passes towards the free surface of the epidermis. In the fibres of the outer circle, it will be seen that they are as a rule quite as narrow and fine at the lower as at the upper surface of the epidermis. It will also be noticed that these outer fibrils, like the centre ones, have a more or less zigzag course, while the fibrils of

the inner circle are (with the exception of the slight curve near the centre) perfectly straight until they become narrow near their ends. These two points are of importance in showing that the three divisions of fibres are anatomically different from each other, a question to be taken into consideration in afterwards establishing homologies.

The fibrils of the inner circle can generally be traced as proceeding from the medullated nerves which pass to the organ. These medullated nerves are generally from four to six in number, and on arriving at the lower surface of the epidermic downgrowth of the organ they divide into two or three branches, which are the fibrils of the inner circle. We have never yet been able to trace any connexion between the medullated nerves on the one hand, and either the centre or outer circle groups of fibrils on the other. What may be called the epidermic matrix of the organ stretches down beyond the general level of the lower surface of the epidermis as a bell-shaped projection, having the appearance as if a mass of epidermic cells in the form of a biconvex lens had been attached by one of its sides to the lower surface of the epidermis; and the medullated nerves pass to the lower or free surface of this lens-shaped body, where they break up into their ultimate fibrils, which enter the epidermis from that lower surface of the lens-shaped mass. Below the same surface of the mass, one or two small Pacinian bodies may be seen, which appear to have no homology with any part of the nerve-apparatus on hairs, are indeed without any representative in the noses of other mammals, although they are plentiful in the beaks of birds; and therefore it will be unnecessary for us to refer to them again*. The *medullated* nerves seldom approach the organ in the line of its axis, but form an intricate plexus beneath the epidermis; and from this plexus nerves are given off at opposite points, which approach the base of the organ from the sides, and meet below the epidermic downgrowth, where they suddenly take a turn at right angles to divide and enter the epidermic downgrowth.

Ganglion-Cells and Group of Central Nerve-fibrils.—Amongst the epidermic cells forming the lens-shaped downgrowth, Mojsi-

* Since writing the above, we have found reasons for considering that these Pacinian bodies are the representatives of one or more forked tactile nerve-endings which have not entered the epidermis and have become covered with connective tissue, like the cut ends of the nerves in an amputated stump. This gives the clue to the origin and function of the large Pacinian bodies in Man and in the Cat tribe.

sovics discovered certain peculiar-shaped cells (seen at *c*, fig. 1, Plate XIII.) which in his opinion were nervous in character. These cells are from two to six in number; and in our opinion there can be no doubt that they are absolutely identical, both structurally and functionally, with the nerve-cells which we have discovered upon the ordinary hairs, as seen at *c*, figs. 6 & 7. Hitherto we have been unable to trace any connexion centrally of these cells with the medullated nerves; but on several occasions we have been able to trace fibres passing off from them peripherally, which form part of the central group of fibrils in the organ of Eimer. These cells have no doubt connexions centrally with some of the numerous non-medullated nerves which accompany the medullated nerves to the organ; but, owing to the number and closely massed condition of all these fibres, it has been impossible for us to trace their connexions with the cells. The drawing which we give in fig. 15, Plate XIV., of one of the isolated cells found on the follicle of an ordinary hair may, we think, be taken as a representation of any of the cells found in the epidermic downgrowths in the organ of Eimer *.

There still remains but one element in that organ to be described, that of the nerve-fibrils of the outer circle.

Nerve-fibrils of the Outer Circle.—From what we have already said, it will be evident that this group of fibrils is both anatomically and physiologically distinct from those of the inner circle. We have never seen them in direct communication with the medullated nerves, although doubtless they are connected indirectly with them by means of the subepidermic plexus of non-medullated nerves, which is largely represented in the nose of the Mole, as apart from the separate plexus of medullated nerves. Indeed these fibrils of the outer circle appear only to be branches of the subepidermic plexus of nerves; and so far they are to be considered the representatives of the intraepidermic fibrils that are found in the epidermis covering the noses of most mammals. As they pass towards the corneal layers they are often seen to give off branches, which is never seen to take place in the fibrils of the inner circle. For the same reason that they represent the intraepidermic fibrils, they represent equally the intraepithelial fibrils, which we have already described as ramifying between the

* We have lately discovered that the touch-bodies on the fingers and toes of the Mole are identical with the organ of Eimer on the snout, minus the intraepidermic fibrils. This provides us with a valuable link in showing that the touch-bodies are composed of the nerve-apparatus of aborted hairs.

cells of the epidermic lining of the hair-follicles both in feelers and ordinary hairs; and so far only does any question of their homology with any nerve-element found in hairs come within the scope of this inquiry.

These fibres are alone represented in the noses of other classes of the Insectivora, as, for example, in the Hedgehog, fig. 25, Plate XVI. The causes and conditions of their existence in the organ of Eimer are quite apart from those concerning the existence of the fibrils of the inner circle and of the centre group there; but these will be considered hereafter when we have disposed of the question of homology between that organ and the nerve-apparatus in hairs. The cause of the little swellings on the course of intraepidermic nerves, wherever found, is as yet obscure. Although apparently it is a modification of the fibril due to the pressure or the presence of the epidermic cells there, and sometimes due also to other conditions elsewhere, we must be content with merely registering the fact, without pretending to be able to account for it. The shape of these little bead-like swellings differs under conditions as obscure as their very existence: sometimes they are triangular in shape, as in the organ in question, *i f*, fig. 2, Plate XIII., or in the snout of the Hedgehog (fig. 25, Plate XVI.)—sometimes globular and stalked, as in the same organ; and sometimes they are fusiform dilatations or beads, as on the lower portions of the fibrils of the inner circle, both of which are seen in figs. 1 and 2, Plate XIII. The presence of moisture seems even to increase the size of these beads, as shown in fig. 27, Plate XVI., from the mucous membrane of the palate in the Mole.

The Organ of Eimer a retrograded Hair-follicle.

We have now arrived at the point where we may claim to establish a complete homology between the nerves composing the organ of Eimer and those nerves found upon an ordinary hair-follicle. To make this clearer, we place them in parallel columns.

Hair-follicle.	*Organ of Eimer.*
Forked terminations.	Fibrils of inner circle and Pacinian bodies.
Nerve-ganglion-cells.	Nerve-cells at base of epidermic downgrowth.
Peripheral fibres of nerve-cells.	Fibrils of the centre group.
Nerves forming Jobert's coils.	Subepidermic plexus of non-medullated fibres.
Intraepidermic fibrils of follicle.	Fibrils forming outer circle.
Medullated afferent nerves.	Medullated afferent nerves.

The different elements on the two structures seem to accord so perfectly, that the wonder is that no one should have previously observed the identity between them. The identity might, however, have been suspected, although, the knowledge of the character of the nerve-elements being very recent, it would have been impossible without it to have demonstrated that identity. We have to remember that it was only in 1878 that the forked terminations on the hairs, the homologues of the most prominent elements in the organ of Eimer, were discovered; and we ourselves are now demonstrating for the first time the existence of nerve-cells on ordinary hairs and their peripheral continuations (figs. 7 and 15), which represent the fibrils af the centre group proceeding from the nerve-cells at the base.

At the time when Mojsisovics, who has made the most complete inquiry into the character of the organ of Eimer, published his researches in 1876, neither the forked terminations nor the nerve-cells with peripheral fibres were known; and as these really form nine tenths of the organ, it need be little wonder if he failed to observe an identity between it and the hair-follicle.

The next question is the very interesting one of how the Mole, and the Mole alone, came to be possessed of so unique and peculiar a nerve-terminal organ on its snout, and upon its snout only; for on the under lip we have only the ordinary intraepidermic fibrils as they are seen on the lower lip of other mammals (*i f*, fig. 25, Plate XVI.). A very little observation of the peculiar habits of the Mole will enable any one, we think, on reflexion to understand one of the prettiest lessons on the effect of habit in causing the evolution of what at first sight may appear to be strange and unique structures, microscopic in size, and consequently less tangible than, for example, the alterations in the fore paws of the same animal.

Effect of Habit in causing Evolution of Organ of Eimer.

Any one who has watched a Mole digging into earth, and noted the energy and force with which it uses its powerful hands and the direction in which they are moved, must have felt that if the animal were suddenly provided with a set of feelers like a mouse or rat, these would be certainly torn out by the roots by a few powerful strokes of the digging hands. Such has evidently been the case in the remote past with the hairs on the extreme point of the snout of the ancestors of the whole Mole family; and

these hairs, having been torn out, it may be during many successive generations, became subject to the now already well-known phenomena in heredity, and ceased altogether to grow upon their descendants. Athough, however, the hairs were torn out and subsequently ceased to grow, the hair-follicles, with the nerve-terminal arrangements upon them, remained behind. Contraction of the empty follicle followed, as a matter of course, when the distending hair no longer existed there; and so, by gradual shrinking-up into the surface-epidermis of the empty follicle carrying with it the nerve-terminations upon it, we have, as the natural result of this involution of the hair-follicle and its nerves, the evolution of the organ of Eimer.

It was not merely, however, that the hair-follicle (originally a developmental downgrowth from the epidermis) ceased to grow downwards into the dermis; for then we should have no right to expect the nerve-terminations peculiar to the hair-follicle to appear upon it. What we have, then, in the organ of Eimer is really the fully equipped representative of structures that in the fulness of time had acquired complete development, equal to that possessed by them at the present day, on other portions of the body of the same animal, as is seen in fig. 3, Plate XIII., from a hair-follicle on the tail of the Mole, only half of which has been drawn, in consequence of its large size and the impossibility of including it within one field of the microscope, in order to draw it under a very high magnifying-power. The regular and parallel condition of the forked terminations in that drawing bring one even nearer to understanding the involution which has taken place, than by studying the terminations that appear so irregularly placed in the hair-follicle from the Horse, shown in fig. 7. How the involuted terminations of the nerves on the hair-follicle came to occupy their present precise position within the epidermis we cannot at present explain; but, as science progresses, we have every hope that every separate phase of evolution between hair-follicle and organ of Eimer will yet be followed and portrayed, it may be on animals belonging to other classes, or upon one and the same animal.

Another special reason, in addition to the one we have mentioned, as proving that the hair-follicle and its nerve-apparatus had been fully developed before retrogression took place, is that we believe the organ of Eimer not to be the only form of modification of the hair nerve-apparatus which exists in the animal kingdom.

Without passing to animals lower in the scale than mammals, we have every reason to suppose that the touch-corpuscles, or corpuscles of Meissner, on the smooth surface of the fingers and toes of man and of many of the lower animals, are also representatives of modification of the nerve-terminal apparatus belonging to hairs. Unlike, however, the organ of Eimer, the touch-corpuscles, to our minds, represent an aborted condition of the hair-nerve apparatus, the hair-nerves having originally developed and become modified as in the case of the organ of Eimer; and we are only surprised that no one has noticed even the probability of this origin for the touch-corpuscles.

It is not our intention to enter further into the question of the homology of the touch-corpuscle with the hair-follicle and its nerves at present; but any one who has studied the development of these corpuscles in the infant cannot fail to recognize in the disk-like expansion and elongated thickenings on its nerves the elements we have described in the hair-follicle. That the group of nerve-endings forming the touch-corpuscle never enter the epidermis, is probably accounted for by the development of the hair, or rather of the connective-nodule part of it.

Leaving out of consideration the fibrils of the inner circle, the homologues of the forked endings on the hair-follicles, which do not appear to be represented at all on the hairless portions of the skin, all the other elements of the organ of Eimer have their homologues in that portion of the skin where they exist under conditions which give indications as to function and direction of growth that we look for in vain either upon the hairs or the organ of Eimer. We even think that it is unfortunate that others should have made of that organ the test or foundation upon which an important hypothesis as to the direction of growth of intra-epidermic nerves should have been founded. From what we have already said, it must have been abundantly evident that the nerve-arrangement in the organ is an abnormal one, more especially the inner circle of fibrils, which represents structures nowhere else found within the epidermis, or any other part of the animal-body that we are aware of. Yet it is precisely upon the crumbling away of the superficial or peripheral points or buds of that portion, that Ranvier rests his hypothesis of the direction of growth of intraepidermic nerves.

The Tail of the Mole as a special Tactile Organ.

Before passing from the consideration of the nerve-arrange-

ments on the hairs, we have still to refer to the remarks which we made at the commencement of this paper regarding the use made by the Mole of its tail as a tactile organ. Unaware at the time that Jobert had previously considered the tail as a special tactile organ in Rats and Shrews, we set about looking for the evidence given by histological examination; and then, as already stated, we rediscovered for ourselves all the elements we have described, in ignorance that Jobert's ring and the forked terminations had already been described, although the nerve-cells and their continuations still remain as original observations. But in the tails of Rats and Shrews we now know that there is nothing peculiar in the nerves of the hairs distinguishing them from those on the other portions of the body; and therefore any claims of Jobert in this respect fall to the ground. With the Mole, however, things are very different in two respects. In the first place, the forked nerve-endings on the tail of the Mole are three or four times as numerous as those found on the hairs of the trunk, and twice as numerous as those found on the stout hairs in the nose of the Horse, as will be seen on comparing fig. 3 with fig. 7. In the second place, the hairs on the tail are several times thicker and stouter than those on the trunk, so that the resistance which they can apply to objects must react with greatly exaggerated effect upon the organs of touch on the hair-follicle, just as any one of us could guide himself in the dark better with a stout staff the length of a peacock's feather than with the feather itself. For these two reasons we consider the tail of the Mole to be specially developed as a tactile organ; and probably the same may be said of the tail of the Hedgehog, for the same reasons. Laying aside the few short feelers found near the muzzle of the European Mole, but not represented (at all events macroscopically) on others of the family, there is only one other spot on the body of the Mole where the tactile apparatus on the hairs is specially developed; and that is on the back of his paws. We have already referred to the manner in which the Mole passes his food into his mouth by holding it with the backs of his digger paws, which are covered with short stout hairs somewhat similar to those on the tail. These hairs seem to serve two purposes by their stoutness: they serve to increase the sense of touch, even of so soft an object as an earthworm; and they, no doubt, by their bristly character, enable the animal to hold the wriggling slippery prey securely while he conveys it to his mouth.

Ranvier's Hypothesis of Direction of Growth in Intraepidermic Nerves.

At the conclusion of his article, "On the Terminations of the Nerves in the Epidermis," in the 'Quarterly Journal of Microscopical Science' for 1880, Professor Ranvier gives out the following hypothesis on the direction and growth of the intraepidermic nerve-fibres, as borne out by the drawings by Karmanski of his preparations from Man, the Pig, and the organ of Eimer in the Mole. At page 458 he says:—"The nerves which enter the epidermis, whatever may be the form or extent of their ramifications, are subject to continuous evolution. They grow, while at the same time their terminations undergo gradual degeneration; this degeneration leads to the formation of granules of nervous substance, which become entirely free, and are soon transported into the inert layer of the epidermis."

The above is merely an accentuation of Professor Ranvier's views regarding nerve-development as expressed on page 75 of the second volume of his excellent work, 'Leçons sur l'histologie du Système nerveux,' that the axis cylinders, forming as they do, part of the nerve-cells in the central nerve-centres, develop centrifugally from these centres. As far as the space between the nerve-centres and the lower surface of the epidermis is concerned we are quite in accord with him, but on arriving there our views become divergent.

A careful study of a very large number of preparations of all the different parts of many different classes of animals, leads us to the conclusion that the great plexus or system of non-medullated nerve-fibres and nerve-cells found immediately under the epidermis is a system apart and quasi-independent of the central nerve-systems. As the name and position of that plexus implies, the direction of its fibres as regards the surfaces of the body is lateral; that is to say, the fibres run in a plane parallel to that of the lower surface of the epidermis, as shown in fig. 28, Plate XVI., which is a drawing from a silver preparation of the subepidermic plexus of fibres and nerve-cells from the skin of the Hedgehog, shown from the plane of the outer surface of the epidermis. On what may be called the central surface of this plexus, numerous medullated nerves join it (*m*, fig. 28), and thereby bring it into connexion with the central nerve-centres; but we hold that anatomically these medullated nerves terminate in the plexus; and on joining it, their peripheral direction of growth, in which

we agree with Ranvier, has entirely ceased; and even although the connexion of a few of these with the plexus at a certain point were severed, not only would that portion of the plexus not degenerate, but through its plentiful connexions in the plexus it could communicate, through other remaining nerves a short distance away, with the central nerve-centres. On the other surface, that is to say the peripheral or epidermic surface of the subepidermic nerve-system, branches may be given off into the epidermis; and it is a point which no previous observers seem to have noticed, that the intraepidermic nerve-fibrils are not given off from medullated nerves (the apparent exception of the inner circle of fibrils in the organ of Eimer being an abnormal condition, although depended upon by Ranvier), but from the subepidermic nerve-system, of which they are only branches. In hundreds of specimens which we have carefully examined, we have never yet met with a medullated nerve passing up to the epidermis and giving off non-medullated fibrils into the epidermis, as Ranvier's theory would imply; but at the same time there is no reason why, *as rare exceptions*, such a condition may not be found, as indeed has been drawn by Merkel: but the cause of this exception will be clearly shown hereafter.

But we are prepared to prove, what may appear to nerve-histologists the most astounding part of our proposition, that the intraepidermic nerve-fibrils do not penetrate into the epidermis of their own accord, but are dragged there against their will and against their tendency to lateral direction of growth—that, indeed, the free ending of a fibril within the epidermis is an accident or a mutilation, resulting from the breakage of one of the *endless* strands or fibrils of the subepidermic nerve-system which has become entangled among the epidermic cells, and that such free endings, instead of having any special function, such as has hitherto been attributed to them, are probably, by the very act of breakage which made them free endings, deprived of every function. The preparations and reasoning by which we shall prove our novel proposition just referred to, while negativing Professor Ranvier's hypothesis of growth, and showing our hypothesis of lateral direction of growth to be true of the peripheral subepidermic system of nerves, will also negative the important theories of Professor Merkel and others as to the special function of certain portions of the nerve-terminal apparatus in the skin. These we had better explain before entering upon our pro-

mised reasoning. In doing so, we are still true to our text of the organ of Eimer; for Merkel's functional conclusions concern specially the fibrils of the outer circle, the central fibrils, and the nerve-cells at the base of the epidermic downgrowth of the organ.

Merkel's Hypothesis of the different Functions of certain Nerve-elements in the Skin.

In the 'Archiv für mikroscopische Anatomie' for 1876 Professor Merkel, of Rostock, published an account of some peculiar groups of cells which he had discovered on certain of the inter-papillary epidermic downgrowths. Some of these cells appeared to be in direct continuation with some of the medullated nerves in the skin; and he therefore named them terminal tactile nerve-cells. These cells he held to be identical with the terminal cells found on the feeler hairs of mammals that we have already described, and an account of which had previously been published by Sertoli, Dietl, and others. He even extended his comparison of these cells to the cells composing the touch-bodies in the fingers of Man, and to the more simple structures of the same kind found in the beak and tongue of Birds. After giving a full account of these structures, with copious illustrations, from his point of view, he concludes his article with the following opinions as to the comparative functions of these cells and of the intra-epidermic nerves:—"I may therefore express as a fact, that only one kind of nerve-termination in cells occurs in the skin, that is the termination in tactile cells . . . . In the skin of Birds and Mammals two entirely different kinds of terminations, differing in their original plan of construction, occur side by side—the terminations in tactile cells and the terminations in free ends" (*i. e.* intraepithelial fibrils). "One feels inclined to make an attempt to utilize the difference physiologically; and I believe, indeed, that I have grounds for considering the terminations in cells as the real tactile nerves, and the free ends, on the other hand, as nerves of temperature."

To these opinions of Professor Merkel we are entirely opposed. We have, indeed, discovered one circumstance which completely demolishes his hypothesis of separate functions for the two kinds of endings he describes; and that is that his so-called terminal cells and his free endings belong to one and the same nerve-system, and are continuous with each other, so that whatever sensorial function pertains to the one must equally belong to

the other. Further, the cells he describes are not terminal, any more than any point in a circle can be considered terminal; for the various cells are united to each other in a ganglion by fine nerve-fibres, which also unite them with the central nerve-centres and to the subepidermic plexus in general; and it is these fibres which, becoming entangled and broken in the epidermis, constitute the free endings which he describes as having a separate sensorial function from the cells (see figs. 18, 19, and 20, Plate XV.). That the cells themselves should be considered specially tactile is a quite gratuitous assumption; in fact, hitherto it has been merely an unwarranted physiological assumption to suppose that either touch or temperature, pleasure or pain, or any other special kind of feeling is separately manifested through different kinds of nerves or nerve-terminations in the skin. If, however, we are to admit that the sense of touch is conveyed through special nerve-endings, and that the physiological tests which can be tried on one's self are the best, then we should say that it is the forked endings on the hair-follicles that are the true tactile endings, as one may suppose from the sensitiveness of, for example, the hairs on the back of the hand or on the face to the lightest impression, say of the touch of a feather or of a wet thread. Thus if a feather, even downy in character, be applied to the back of the hand where the hairs are found, the sensation is distinctly felt, whereas on the pulp of the fingers it is absolutely imperceptible, although it is there that the tactile cells of Merkel and free endings in the epidermis are most abundant, where the touch-corpuscles *par excellence* (those we have already described as nerves of aborted hair-follicles) are found, which would be sensitive to the ruder touch-impressions, and where the Pacinian bodies, the probable organs of pressure-impressions, also exist.

If with our present knowledge it be allowable to suggest any function for the so-called tactile cells and free endings in the epidermis, and, indeed, for the whole subepidermic nerve-system, which we hold includes the others, we should say that it conveys impressions of heat, pain, pleasure, and in fact all sympathetic sensations; for to the sympathetic nerve-system we consider the whole of what we now describe to belong. It equally influences the blood-vascular system; and under the microscope it is common enough to trace branches upon the smaller vessels, more especially in the papillæ of the skin, that are directly connected and even continuous with intraepidermic branches and with the subepider-

mic plexus in general. That the sense of touch does not belong to this system we would argue from the fact that the piece of down, which excites distinct tactile sensations on the hairs on the back of the hand, may be applied with equal force to the sensitive cornea without conveying the sense of touch, although it may readily excite pain there, if allowed to remain in mechanical contact with it; and we know equally well that, although the epithelial surface of the cornea is more plentifully supplied with free intraepidermic nerve-endings than perhaps any other part of the body, the rubbing of the eyelid does not make itself felt as a tactile sensation, although, in the absence of that rubbing, a very distinct sensation of pain makes itself felt.

That Professor Merkel should have been led into considering the nerve-cells and free endings as belonging to two different systems, is perfectly explicable from the fact that in those researches he used only osmic acid, which fails to show the intraepidermic free endings; but it is curious to find that so great an adept with the gold process as Professor Ranvier should have failed to trace the connexion between the two elements.

Ranvier's Morphological Objections to Merkel's views.

Of the investigators in this special department who have succeeded Professor Merkel and repeated his examinations, Professor Ranvier appears to be the only one who takes direct exception to Merkel's morphological conclusions, while appearing to accept his physiological ones; but even he has failed to observe the connexion (and the cause of it) of the nerve-cells with the free intraepidermic endings, which lies at the root of the whole question. Professor Ranvier's morphological criticism extends to all the four structures or tactile organs described by Merkel—to the touch-bodies in Birds, the touch-corpuscles in Man, the tactile cells in the feelers, and the tactile cells in the epidermis, which we are now considering. In all of these structures Ranvier rejects the interpretations given by Merkel, and applies instead a description which is the result of his own investigations into them; that is to say, instead of admitting them to be tactile nerve-cells, he holds that there are two component elements in each, the *cellules du tact* of Merkel and the "*disques tactiles*" which he had previously described in the touch-bodies of Birds. We have already given Professor Ranvier's views on the terminations in the feelers; and we do not intend to enter further into the consideration of the touch-

bodies, and therefore confine ourselves to the one structure in question. Upon this Professor Ranvier, in his preliminary communication to the Académie des Sciences in December 1880, says:—"On the lower surface of the epidermic downgrowths of the snout of the Pig there exist, according to Merkel, amongst the ordinary epithelial cells, certain special cells in which the tactile nerves end. In reality these nerves, after having penetrated within the epithelium, divide, subdivide, and form, on the cells of Merkel, little concavo-convex disks, which appear semilunar when they are seen in profile in sections made perpendicular to the surface of the integument, but stellate and anastomosing by their prolongations when they are examined from their largest surface. The tactile disks of the Pig's snout have apparently the same signification as the tactile disks of the Palmipedes." Apart from the dual condition of cells and disks, Professor Ranvier's descriptions are a great advance upon Merkel, Bonnet, and others in showing, not that a medullated nerve ended in a cell, but that it ended in a great number of elements connected one with another by fine fibrous continuations. The only difference in this respect between our views and his is, that his nerve-disks are described as being stellate, while we hold that it is the cells that are stellate; but the continuations of his disks with the free intraepidermic endings he has not observed. As to function, his words show that he agrees with Merkel, certainly not with us.

Proofs that the Nerve-cells and Intraepidermic Fibrils are continuous.

The distinguished men who have debated the previous question agree in recommending the snout of the Pig as the best object in which these groups of nerve-cells may be studied. In this we think that they have been unfortunate; for although the groups there are much more common and easily demonstrated than elsewhere, yet, whether it be owing to the fineness of the fibrils uniting the cells or the size and number of the cells themselves, their whole history cannot be so easily traced as in some other animals. After searching in a large number of animals, we find none so suitable for this purpose as the Horse; and our figures 19 and 21, from that animal, put a different interpretation upon those cells from any that has hitherto been suggested. That group is only one of scores of similar preparations in our possession, which show the same junction of cells with intra-

epidermic fibrils or free endings in every stage of growth. Sometimes these fibrils are single and pass perpendicularly through the epidermis, until on reaching the inert layers near the surface they may divide into several branches, and then crumble away into fragments. At other times (and this gives the key to the whole question) they may form a loop or arch, the columns of which rest upon or are continuous (as in fig. 19, Plate XV.) with two or more of the cells forming the ganglionic group lying upon the lower surface of the epidermic interpapillary downgrowth, showing that the so-called terminal nerve-cells belong to the same nerve-system as the intraepidermic nerves. Next to the important fact that they are so connected, comes the question of how the fibres come to lie throughout the epidermis. This we think we are able to explain, and in doing so to describe a new power, hitherto unrecognized, but whose existence will account for other phenomena connected with the nervous system, to which we shall also call attention.

First, let it be understood that the branched nerve-cells we are now considering are often found in large numbers forming groups at various localities and depths in the dermis, and that they appear to grow up upon, or are prolonged with the nerve-fibres, generally non-medullated, to which they are attached. The conditions of their presence there, however, seem to be very variable, as if the groups made their appearance there by fits and starts; for in two contiguous localities in the skin of the same animal one may be full of these cells and the other destitute of them. When found, however, they are seen to be evidently growing up towards the epidermis. There they become arrested, either on the lower surface of the epidermic interpapillary downgrowths or within the papillæ themselves, which sometimes become stuffed full of such cells. In fact, the cells collect against any obstruction as drift-rubbish collects before a grating on a stream. So closely do the cells apply themselves to the lower surface of the epidermis, that they become flattened and show a slight concavity towards the free surface of the skin. At other times they get jammed between the epidermic cells, more especially on the sides of the dermic papillæ, so that, when cut through in perpendicular section, they appear quite narrow and elongated.

In fig. 19, Plate XV., we have a group or ganglion of such cells flattened against the lower surface of the epidermis, the

different cells being connected with each other and with the central nerve-centres by one or several fibres. Once there, what seems to occur is as follows. The epidermis is, as is well known, continually being renewed by the addition of new or younger cells, probably by the addition of wandering or embryonic cells to its lower surface. If these living wandering cells apply themselves at a point where lies a nerve-fibril connecting two cells in a ganglionic group, that nerve-fibril probably becomes entangled in the epidermis. Once fairly entangled, the fibril cannot free itself; for the continuous development of young cells on the lower surface of the epidermis keeps going on, and the fibril becomes only more deeply involved among the epidermic cells. The younger cells keep pushing the fibril before them towards the free surface; and as the ganglionic basal cells are comparatively fixed, the fibril connecting them is forced to elongate itself, and becomes bent, with its convexity towards the free surface. As the fibril becomes pushed further on, we find it appearing like a narrow arch (as in *i f*, fig. 19, Plate XV.) resting on two high piers or columns, each of which has its base upon or in a nerve-cell in the ganglionic group. By-and-by the arch gives way through extreme tension, as at *g*, fig. 19, or through being carried to the free surface of the epidermis, leaving in either case the two columns standing as two fibrils perpendicular to the surface. Every stage of the process as we have described it can be seen in one or other of our preparations. Even when the arch is broken, there is still no chance for the fibrils to retract upon their respective base-cells; for they are as firmly held between the epidermic cells growing outwards as a rope would be if grasped and drawn along between a series of toothed wheels moving in one direction; and so the fibrils continue to be drawn out in spite of themselves, to moulder and crumble away at their free ends in the inert portions of the epidermis, and to be thrown off with the dead epidermic cells.

But the interesting process which we have described is not merely confined to the fibrils connecting the cells in a ganglionic group, which do not form the hundredth part of the intraepidermic fibrils seen in any locality. The advantage of watching the process going on in such a group arises from the fact that the cells form a comparatively fixed point of observation, whose relation to the intraepidermic offshoots from them can always be calculated Once, however, the process has been verified in such a locality, it

is evident that it will be of equal application over all the subepidermic plexus of nerves, even where no cells exist, and that this is really the cause of the presence of non-medullated nerve-fibrils within the epidermis. Moreover a careful examination of suitable specimens will show that, although for some time such fibrils continue to be spun out or drawn out into the epidermis, they are continually rupturing at the base, and even during their passage through the epidermis. In the former case the epidermic cells lose catch of the dermic end of the fibril; and subsequently no intraepidermic fibril will appear to grow at that spot, while the broken fragment gets rapidly carried to the surface and thrown off with the worn epidermic cells. This continual entanglement is equalized by the continual breaking at the dermic surface of intraepidermic nerves; and thus it is that a very old animal shows no greater quantity than a young animal of such fibrils, perhaps even less, as we have ourselves seen—a feature due probably to a slower development of epidermic cells in the older animal. But what we have said of the entanglement of fibres in the epidermis applies equally to the cells themselves, which leads us on to another important problem hitherto unsolved, although often attempted, namely the origin of the cells of Langerhans.

Origin of the Cells of Langerhans.

It would appear, from our preparations, that the cells upon the course of the non-medullated nerves become quite as often entangled in the epidermis as the intraepidermic fibrils, whether these cells be solitary or belonging to large ganglionic groups. We have already alluded to the fact that such cells often lie squeezed between the lower layer of epidermic cells; and were it not for such appearances as are shown in fig. 19, Plate XV., we should have been inclined to consider the position of the nerve-cells among the lower cells of the epidermis the prime factor leading to the presence of intraepidermic fibrils. There can be, however, no doubt that this is also a constant cause of their presence there; but at the same time we cannot admit that such groups of cells lie normally performing their functions while imbedded two or three layers of cells deep in the epidermis. Be that as it may, it is undoubted that such nerve-cells get carried away into the epidermic stream. If the connecting fibrils between the cells in a group are weak, the cells may be broken off,

as at n, fig. 23, Plate XVI., from the nose of the Bullock, and carried away, one by one, into the epidermis; but if the connecting fibrils are strong, we may find the whole ganglionic group carried wholesale into the epidermic stream. The Horse seems to be a peculiarly suitable animal in which to watch this process, on account of the strength of the connecting fibrils; and among our preparations from this animal we have every stage in the process represented, from the first entanglement of the ganglion to the point when the rear cells of the ganglionic group are about to disappear (lost in the stratum granulosum) near the free surface of the epidermis, as shown in fig. 21, Plate XV. It is, however, generally as broken-off solitary cells that these are seen in other animals, more especially in inflammatory conditions of the skin, when such cells abound; and it is these cells, due to the process of entanglement which we have described, that are called the cells of Langerhans.

During the early days of the gold process, Langerhans described, in Virchow's 'Archiv' for 1868, certain peculiar branched and deeply stained cells within the epidermis of Man, which he considered to be nervous in their nature. Two years afterwards Eberth took up the question, and, while confirming Langerhans's discovery, denied the nervous character of these cells, which he supposed were either pigment-cells or wandering cells. Since then every investigator in this department has made his guess as to the character of these cells. Some, like Merkel, have supposed them to be unpigmented pigment-cells; others (Krause for example) supposed them to be those apocryphal structures, the radicles of the lymphatics; but the greater number (including Arnstein, Bonnet, and Ranvier) accept Eberth's last suggestion, and consider them to be wandering cells. All deny their nervous nature; but it is to be hoped that after the explanations we have given their character will be no longer doubtful, and that the hypothesis of their discoverer fourteen years ago will be accepted as correct. With reference to any identity between them and the cells of Merkel, the latter histologist declared that his cells were certainly not branched, while Bonnet gives drawings of the two in the same spot, and thinks that he disposes of their identity by showing that Merkel's cells are oval and Langerhans's cells branched. He evidently was unaware that Merkel's cells when seen broadside are branched, and that when they are broken off and distorted by the pressure of the epidermic cells

among which they lie, their appearance becomes greatly altered. Moreover, on being broken off from their centres, these nerve-cells probably die and degenerate, thus accounting for the intense pigmentation they acquire from the action of the gold solution.

Have the Intraepidermic Nerve-fibres any Function?

Just as we look upon the cells of Langerhans as dead elements, so, in opposition to the whole histological world, are we inclined to look upon the intraepidermic nerve-fibrils as practically useless; for it is rather unusual to look upon broken nerve-fibres as capable of performing their normal functions. From what we have said, it must be clear to every one that the free ends of these nerves, in the epidermis, are due to unnatural causes, which ought to have put an end to functional activity, and that after they reach the stratum granulosum structural death has also overtaken them. That they retain vitality and a capacity for growth up to that layer we quite believe; and the proof of it lies in the fact that, short of it they endeavour to push out lateral offshoots, which, like themselves, are carried into the stratum granulosum to be destroyed. This fact brings us back to Professor Ranvier's hypothesis as to direction of growth in the intraepidermic nerve-fibrils, and the continuous or uninterrupted character of that growth (p. 576), to which we promised to return.

Professor Ranvier's Hypothesis of Growth of Intraepidermic Nerve-fibrils negatived.

We have already shown that these nerves, instead of having the power to grow through the epidermis and carry on continuous evolution, as stated by Ranvier, are really passive agents, and are dragged into and through the epidermis to their destruction, in opposition to their own natural tendency to lateral growth, as shown in the position of the whole subepidermic plexus of nerves and nerve-cells (see fig. 24, Plate XV.).

Apart, however, from any argument to be derived from the position of that plexus, we have this further proof, shown while the nerves are being dragged through the epidermis. If the breakage occurs while the arch or nerve lies among the lower layers of cells in the epidermis, the broken end at once begins to push out lateral branches in every direction, as if anxious to form a junction with any other nerves in the neighbourhood. A striking example of this kind is seen in the nose of the kitten, of which we give a drawing in fig. 24, Plate XV., which speaks for

itself. That figure was by no means an exceptional one; indeed every specimen we possessed, in above a hundred cases, showed all the same condition; and in some cases the two fibrils resulting from the breakage of the loop or arch lay side by side, each pushing out lateral branches after the manner shown in fig. 24. The same tendency is shown in the fact referred to in the previous chapter, that, even while the termination of the nerve-fibril is undergoing degeneration in the inert layers of the epidermis, it may be pushing out branches from its living portion, which are carried out with it nearly at right angles to the epidermis to perish in the inert layers. That those fibrils appear generally to lie at right angles to the surface is due, we think, solely to the rapidity of the growth of the epidermis; and they will also be found most numerous where, amongst other things, growth of epidermic cells is going on fastest. At the surface or summit of the vascular papilla, the growth of epidermic cells seems to go on more rapidly than elsewhere; and thus it is that the entanglement of nerve-fibres, as shown by their greater number, seems to go on much faster there than on the interpapillary portions of the surface of the epidermis, where the fibrils are much fewer. If this be true, we should naturally expect that, on portions of the epidermic surface which were unexposed to rubbing or wearing, the growth of the cells would be slow, and any intraepidermic nerves which were found there, instead of being carried rapidly at right angles to the surface, would find time to ramify laterally. This is exactly what happens in the protected epidermic lining of the hair-follicle, as shown in fig. 17, Plate XIV., where the fibrils find time to exercise their natural tendency to lateral development, instead of being hurried through at right angles to the surface. We submit, therefore, that we have shown Ranvier's hypothesis to be untenable.

Subepidermic Plexus of Nerve-cells and Fibres.

We have often referred, in the course of this paper, to this plexus as an important element in the cutaneous nerve-supply, and described it (p. 576) as being almost an independent system, although no investigator, to our knowledge, calls attention to it. This we believe to be due to the difficulty of showing it, as a plexus of non-medullated fibres, from the plane of the surface of the skin; and we were only enabled to do so by certain technical modifications devised by ourselves. It cannot be shown

to any extent in the skins of large Mammals possessing papillæ, as the plexus fellows all the undulations in the dermic or epidermic surface; and consequently in a section parallel to the surface of the skin, either the projections or the hollows would be cut away, with the portions of the plexus lying there. We succeeded in showing it by stretching the skin of the smaller Mammals, taken shortly after death, upon the histological rings invented by us*, where it was shaved with a sharp scalpel to the extent not merely of taking off all the hairs, but of taking off also the epidermis, leaving at most only the cells belonging to the lower layer still upon the dermis.

To this shaved surface a 1-per-cent. solution of nitrate of silver was momentarily applied, and the surface after some time washed, and the images produced by the solution developed. A similar solution of chloride of gold was then similarly applied, and the surface afterwards washed, clarified with glycerine, and mounted as a preparation. Figs. 28 & 29 are drawings of such preparations, where the fine protoplasmic fibrils and cells, having remained unaffected by the reagents, now appear as negative images in the gelatinous field of the skin. At *m* a medullated nerve is seen joining the plexus, of which the various groups of cells represent the so-called terminal cells of Merkel. A few of the outlines of the cells of the lower layer of epidermis, *e*, have also been inserted, to show their relations to the plexus. Where the fibrils appear to end, it only means that at that point they either passed up into the epidermis and were cut off, or that they passed downwards into the dermis beyond the reach of the effects of the reagents employed.

This plexus corresponds to the subepithelial plexus of nerve-fibrils of the cornea, which has been so often described; but the subepithelial layer of tissue there, being destitute of blood-vessels, papillæ, or large ganglion-cells, shows a much more regular plexus than the skin of the trunk. Even in the smaller Mammals the difference in the arrangements of the blood-vessels causes considerable modifications in the appearance of the plexus. Thus, for example, the skins of Moles and Rats possess a very regular arrangement of meshes formed by blood-vessels of equal calibre throughout, which lies immediately under the epidermis in one general level, and the greater part of the subepidermic plexus of cells and fibres runs alongside of the blood-vessels,

* "Lymphatiques de la peau," in 'Journal de l'Anatomie,' January 1879.

recalling the drawings of Dr. Lionel Beale of such nerves and blood-vessels, with which, indeed, they are identical.

In the Hedgehog, on the contrary, from which fig. 27 was drawn, there is no such regular superficial plexus of blood-vessels; and the spaces between the groups of hair on the belly being perfectly flat and transparent, we have the appearance presented in fig. 28, where the irregularity of the nerve-plexus seems absolutely unaffected by the irregular character of the blood-vessels. The irregularity there resembles somewhat the plexus as it exists in the larger Mammals, which, however, is generally seen only in perpendicular sections showing the side views of the fibrils.

The number of cells forming the groups also varies much in different animals. In Man they are very few; in the Pig they are plentiful. Fig. 22, Plate XVI., gives a drawing of one of the large groups we have found on the lower surface of the epidermic downgrowths of the snout of that animal, as seen from our point of view and preparation, and drawn by the aid of the camera lucida. It will appear to differ considerably from the drawings published by Merkel, Bonnet, and Ranvier. We have omitted altogether the epidermic cells from the drawing, below which the group of nerve-cells lay, as they would only serve to obscure it. In that group a medullated nerve joins the plexus, breaking up into two branches before doing so; but alongside of the medullated nerve were several non-medullated fibres, which equally passed to join the plexus, and from the plexus branches were given off laterally to join other portions of the subepidermic plexus. The difference in the size of the cells in different animals may be noticed by comparing this figure with figs. 19 & 21 (from the Horse) and fig. 23 (from the Bullock), all of which were drawn under the same lens and magnifying-power. All these ganglia or groups of cells belong, in our opinion, to the sympathetic system of nerves; and we may mention also, with reference to the medullated nerves which join them, that in some animals, such as the Horse, it is excessively rare to find a medullated nerve joining or apparently having even an indirect connexion with a group, although several non-medullated nerves may be seen passing to it from the deeper part of the dermis.

We are inclined to look upon these groups as peripheral nerve-centres, within the cells of which are generated the currents which convey the sensation of pain or other influences either to the

central nerve-centres of consciousness or of motor action, or to the neighbouring blood-vessels, just as an electric battery is used at a telegraph-station to generate the current which carries the telegraphic message from that station to different distant destinations.

Concluding Remarks regarding the Organ of Eimer.

Finally, what bearing have the considerations contained in the last few pages upon differentiation of structure and function in the subject of our original text, the organ of Eimer? They have shown that the centre fibrils in the organ and the nerve-cells at the base, with which they are continuous, are similar in character to the subepidermic nerve-cells and their intraepidermic fibrillar prolongations. The outer circle of fibrils have equally their existence and nature explained, as well as the cause of their being dragged into their present position in the epidermis. Then, as relates to function, Eimer was certainly correct, or, at all events, within the truth, when he spoke of the organ he had discovered in the Mole as "*a tactile instrument*" ("Tast-Werkzeug"), as it is certainly tactile, and possesses other sensorial functions as well. From what we have said, it may be considered very probable that the inner circle of fibrils, the analogues of the forked endings, provide capacity for the sense of touch, while the centre fibrils and those of the outer circle provide for the sense of temperature, pain, and any functions connected with the sympathetic nerve-system. The Pacinian bodies at the root of the organ, but not properly connected with it, are probably the agents for registering pressure; so that in itself the organ of Eimer is completely provided with the full armament of peripheral nerve-terminations.

List of Authors referred to in the preceding Paper.

Cohnheim. "Ueber die Endigung der sensiblen Nerven in der Hornhaut," Virchow's Archiv, vol. xxxviii.

Langerhans. "Ueber die Nerven der menschlichen Haut," Virchow's Archiv, vol. xliv. (for 1868) p. 325.

Eberth. "Die Endigung der Hautnerven," Archiv für mikroskopische Anatomie, 1870.

Podcopaew. "Ueber die Endigung der Nerven in der Epithelial-Schicht der Haut," Arch. f. mik. Anat. vol. v. p. 506.

Elin. 'Zur Kenntniss der feineren Nerven der Mundhöhlenschleimhaut," Arch. f. mik. Anat. vol. vii. (for 1871) p. 382.

Eimer. "Die Schnauze des Maulwurfs als Tast-Werkzeug," Arch. f. mik. Anat. vol. vii. (for 1871) p. 181.

Mojsisovics. "Ueber die Nervenendigung in der Epidermis der Säuger," Sitzungsberichte der k.-k. Akademie zu Wien, vol. lxxi. part 3 (for 1875), p. 242, and vol. lxxiii. part 3 (for 1876), p. 69.

RANVIER. "On the Terminations of Nerves in the Epidermis," Quarterly Journal of Microscopical Science for 1880, p. 455, and Traité Technique d'Histologie, Part 6 of 1882.

FLEMMING. "Zur Kenntniss der sensiblen Nervenendigungen," Arch. f. mik. Anat. vol. xix. 1880, p. 513.

JOBERT. "Recherches sur les Poils du tact," Annales des Sciences Naturelles, 5e sér. Zoolog., tome xxi. article no. 5, 1872; Comptes Rendus, for 1874, p. 1058, vol. lxxviii.; Gazette Médicale de Paris, January 1875, p. 74.

ODENIUS. "Beiträge zur Kenntniss des anatomischen Baues der Tasthaare," Arch. f. mik. Anat. vol. ii. part 4 (for 1866), p. 436.

SERTOLI. Sulla terminazione dei nervi nei peli tattili: Milano, 1872.

DIETL. "Untersuchung über die Tasthaare," Sitzungsberichte d. k.-k. Akad. Wien, vol. lxiv. part 1, July 1871, part 2, July 1872, vol. lxviii. part 3, December 1873.

SCHÖBL. "Ueber die Nervenendigung an den Tasthaaren, etc.," Arch. f. mik. Anat. vol. ix. 1873.

MERKEL. "Tastzellen und Tastkörperchen bei den Hausthieren, etc.," Arch. f. mik. Anat. vol. xi. for 1875, p. 636.

MERKEL. Ueber die Endigung der sensiblen Nerven in der Haut der Wirbelthiere: 1880.

ARNSTEIN. "Die Nerven der behaarten Haut," Sitzungsberichte d. k.-k. Akad., Oct. 1878, part 3.

BONNET. "Studien über die Innervation der Haarbälge der Hausthiere," Morphologisches Jahrbuch, vol. iv. p. 329 (for 1878).

RANVIER. "Nouvelles recherches sur les Organes du Tact," Comptes Rendus, 27 Décembre 1880.

DESCRIPTION OF THE PLATES.

Drawings made by the aid of the camera lucida. Ocular No. 3. Objective $\frac{1}{12}$ oil-immersion of Zeiss, with the exception of figs. 1, 10, 26, 28, and 29. Afterwards reduced to $\frac{1}{300}$ diameter by photography. The following letters apply to all:—*e*, epidermis; *d*, dermis; *m*, medullated nerve; *n*, non-medullated nerve; *c*, nerve-ganglion cell; *f*, forked terminations of (tactile) nerves; *h*, hair or hair-follicle; *i f*, intraepidermic nerve-fibrils; *o c*, nerve-fibrils of outer circle; *i c*, nerve-fibrils of inner circle; *c f*, central nerve-fibrils; *j*, nerve-coil of Jobert; *p*, papilla of skin. Any other letters are noted in the special description of each figure, or in the text.

PLATE XIII.

Fig. 1. Perpendicular section through the skin of the nose of the Mole, showing the arrangement of terminal nerve-fibrils called the organ of Eimer. *a*, epidermic downgrowth; *p*, Pacinian body. $\frac{1}{200}$. (See p. 567.)

Fig. 2. Transverse section across organ of Eimer in the Mole.

Fig. 3. Forked nerve-terminations on the dermic surface of the epidermic lining of a hair-follicle on the tail of a Mole. The drawing shows only one fourth of the circumference of the hair-follicle. (See p. 562.)

Figs. 4 and 5 are examples of developing nerve-terminal apparatus from a large and a small hair on the nose of a newly-born kitten. (See p. 563.)

Fig. 6. Examples of nerve-terminal apparatus on large and small hair-follicles from the tail of a Water-Shrew. *s*, sebaceous gland. (See also Pl. XIV. fig. 15.)

Fig. 7. Nerve-terminal apparatus on an ordinary hair-follicle from the nose of the Horse. Compare with figs. 4 and 5 under the same magnifying-power. (See p. 556.)

Fig. 8. Transverse section through the epidermic downgrowth of the organ of Eimer in the Mole, at the general level of the lower surface of the epidermis.

PLATE XIV.

Fig. 9. Nerve-terminal apparatus of an aborted or only partially developed feeler hair from the lower lip of the Water-Shrew. It stands midway as to nerve-apparatus between feelers and ordinary hair-follicles. (See p. 564.)

Fig. 10. View, under a comparatively low magnifying-power of 150 diameters, of a portion of the ganglionic nerve-cells connected with a medullated nerve on the follicle of a feeler hair from the nose of a Horse. This figure contains about the twentieth part of the whole.

Fig. 11 represents a small portion of the cells seen in fig. 10 under a doubly magnifying power. (See p. 558.)

Fig. 12. View, in profile, of the course followed by a medullated nerve which, upon losing its myeline at *n*, passes through the basement-membrane *b* of the feeler hair-follicle, and curves downwards and inwards to become attached to the ganglion-cells. (See p. 559.)

Fig. 13 shows portion of a transverse section across feeler hair and follicle from the nose of the Horse. *h*, body of hair; *c h*, cuticle of hair; *c f*, cuticle of hair-follicle; *e*, epithelial lining of follicle, amongst the cells of which intraepidermic nerve-fibrils *i f* are seen ramifying and in connexion with the ganglion-cells *c* on the hair-follicle; *a*, cavities in the cavernous portion of hair-follicle; *b*, basement-membrane of follicle, in which the extremities of two nerves are seen to be bifurcating; *d*, bundles of nerve-fibres passing to terminate on hair-follicle, and seen in transverse section; *g*, peripheral portion of gelatinous layer of hair-follicle. (See pp. 553, 561.)

Fig. 14. Nerve-terminal apparatus on large and small hair-follicles from tail of Water-Shrew. (See also fig. 6, Pl. XIII.)

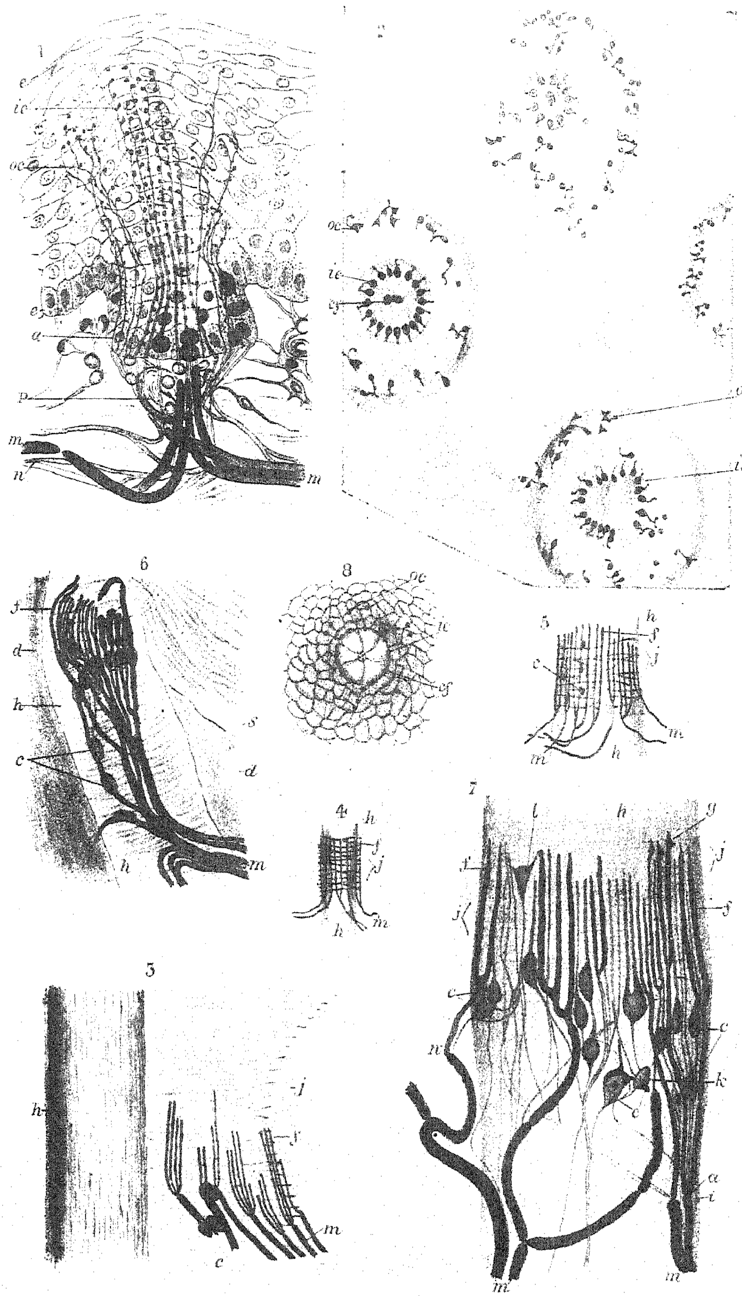
Fig. 15. Isolated nerve-ganglion cell *c* ending in forked terminations, from the follicle of an ordinary hair. These cells on ordinary hairs are seldom seen in connexion with medullated nerves as in feeler hairs. (See p. 560.)

Fig. 16. Subepidermic ganglionic nerve-cells *c* in connexion with intraepidermic nerve-fibrils, the homologues of the cell seen in fig. 15, showing that cell and fibrils cannot have separate nerve-functions as imagined by Merkel and others.

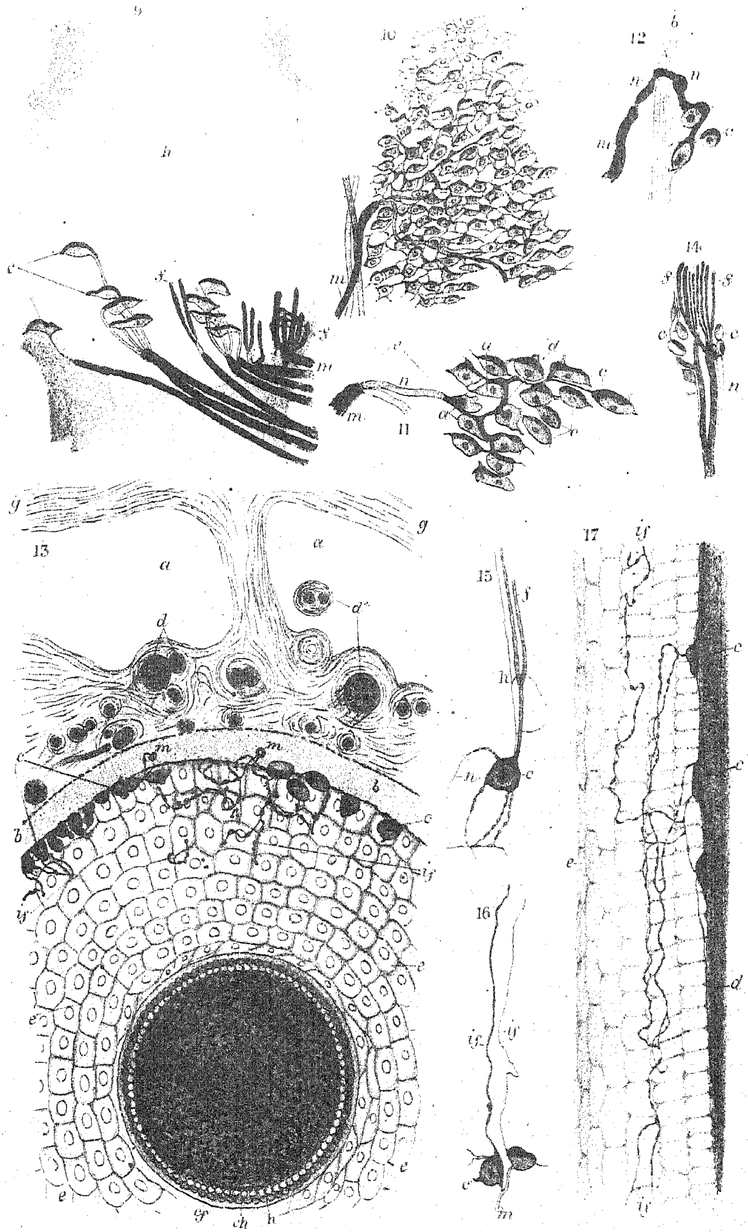
Fig. 17. Intraepidermic nerve-fibrils, *i f*, ramifying amid cells of epithelial lining of ordinary hair-follicle lying between mouth of sebaceous gland and the free surface of the epidermis. (See p. 566.)

PLATE XV.

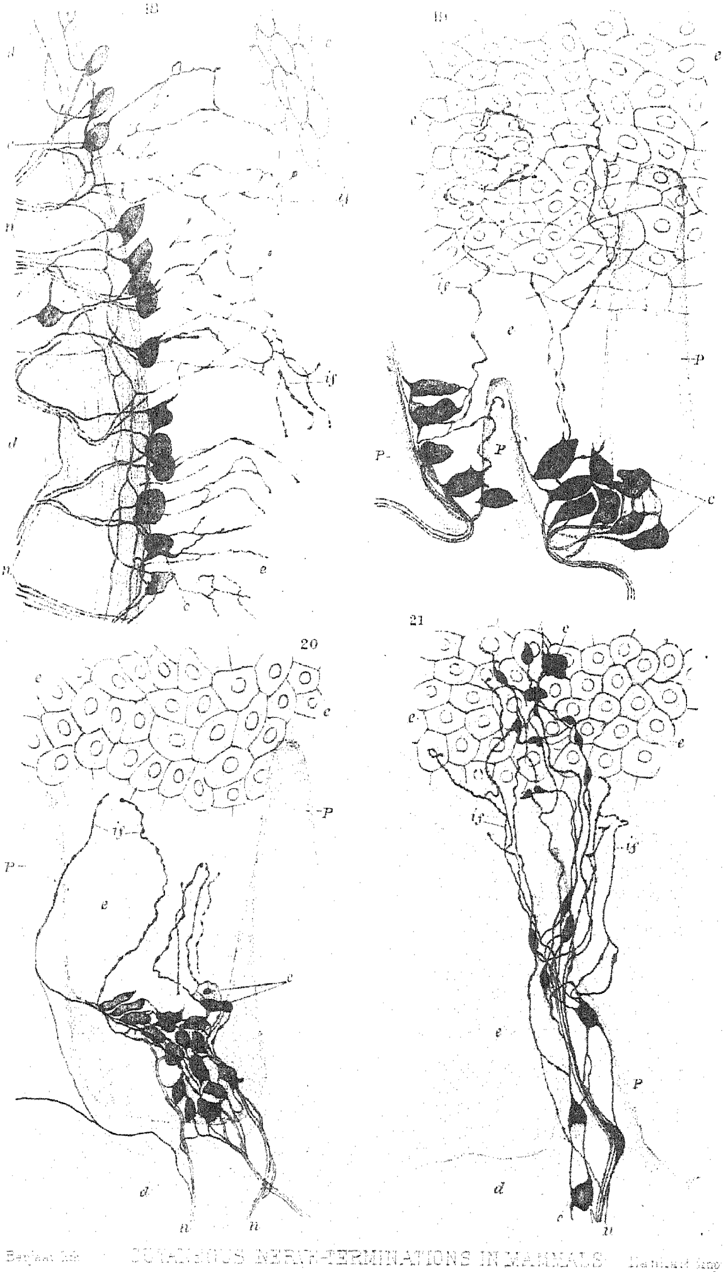
Fig. 18. Subepidermic nerve-ganglion cells, *c*, and intraepidermic nerve-fibrils on the nose of a newly-born kitten. In many cases the fibrils are seen to be continuous with the ganglion-cells.



Berjeau lith. CUTANEOUS NERVE-TERMINATIONS IN MAMMALS. Hanhart imp.



Berjeau lith. CUTANEOUS NERVE-TERMINATIONS IN MAMMALS. Hanhart imp.



Berjeau lith.   CUTANEOUS NERVE-TERMINATIONS IN MAMMALS   Hanhart imp.

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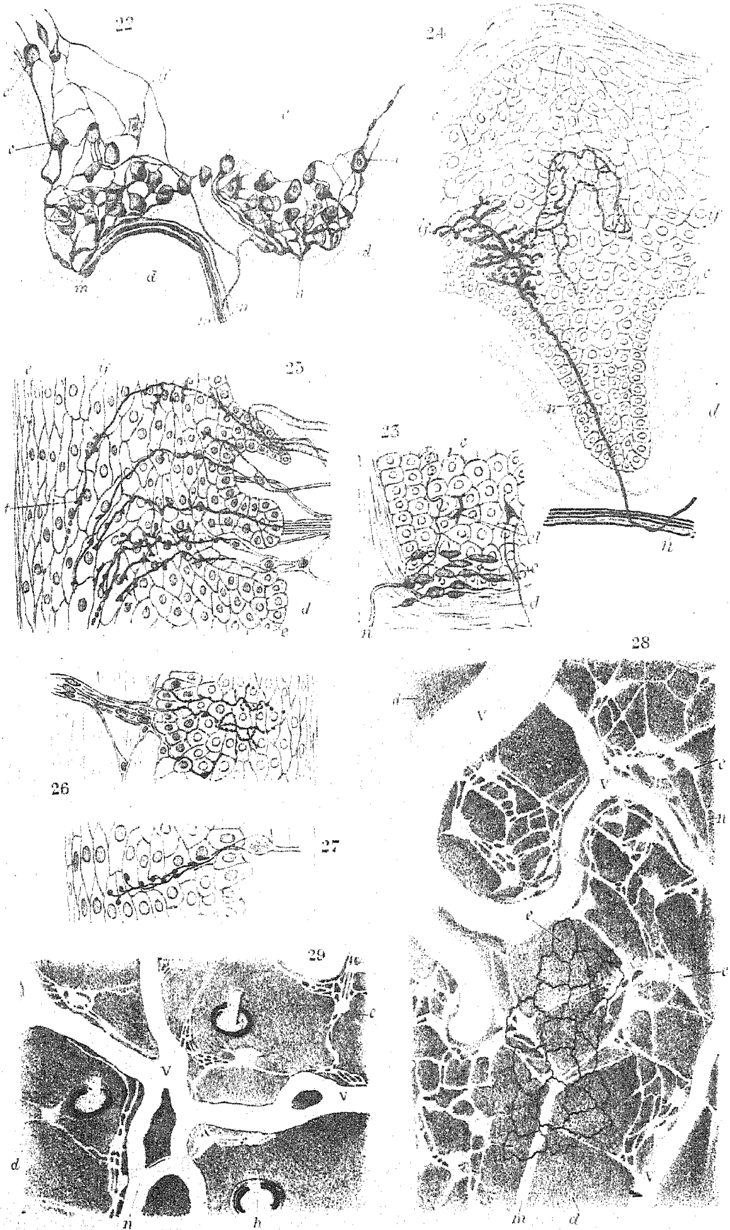

Berjeau lith. CUTANEOUS NERVE-TERMINATIONS IN MAMMALS. Hanhart imp.

Fig. 19. Subepidermic *nerve-ganglion cells c in direct continuation with intra-epidermic* nerve-fibrils, from the nose of the Horse.

Fig. 20. Subepidermic nerve-ganglion from the nose of the Horse, showing the manner in which non-medullated nerve-fibrils of the subepidermic plexus get dragged into the epidermis, where they become the so-called intraepidermic or free nerve-endings.

Fig. 21. Last vestiges of a subepidermic nerve-ganglion, as seen in figs. 19 and 22, which has become entangled in the epidermis, and is now about to be thrown off from the surface, dragging a tangled mass of nerve-fibrils of the subepidermic nerve-plexus after it through the epidermis.

Plate XVI.

Fig. 22. Subepidermic nerve-ganglion from the snout of the Pig.

Fig. 23. Subepidermic nerve-ganglion from the nose of the Bullock. Two of the cells of Langerhans, *c l*, are also seen there, which have evidently broken off from the plexus; in the one to the right the two processes are seen which previously connected it with a subepidermic non-medullated nerve-fibril.

Fig. 24. Intraepidermic nerve-fibril from the nose of the Cat, showing the tendency of the free end to put out branches which tend to grow laterally or parallel to the surface of the dermis, instead of perpendicular to it as supposed by Ranvier. × 250.

Fig. 25. Intraepidermic nerve-fibrils from the snout of the Hedgehog, showing triangular swellings.

Fig. 26. Intraepidermic nerve-fibrils from the lower lip of the Mole.

Fig. 27. Intraepithelial nerve-fibril from the moist mucous membrane of the cavity of the mouth of the Mole, showing large bead-like swellings due apparently to the moisture.

Fig. 28. Silver preparation of subepidermic nerve-plexus of non-medullated fibrils and branched cells, from the surface of the skin of the Hedgehog: *e*, outlines of lowest layer of epidermic cells; at *m* a medullated nerve is seen joining the plexus. This may be taken as the type of an irregularly placed nerve-plexus in the dermis. × 200.

Fig. 29. Silver preparation of the subepidermic nerve-plexus in the skin of the Rat, where, owing to the fibres accompanying the large regular plexus of veins, they form regular bundles from which twigs are given off to the hair-follicles. × 200.

Mollusca of H.M.S. 'Challenger' Expedition.—Part XV. By the Rev. Robert Boog Watson, B.A., F.R.S.E., F.L.S.

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[Read June 15, 1882.]

Fam. Ranellacea.
Muricidæ.
Fam. Scalariidæ.
Solariidæ.

In the following group the very peculiar form of the *Nassaria* led to its being misplaced, and so overlooked at the right time. The *Murices* are few in number, and, though not without interest, are poorly represented in the specimens which have been found. The *Scalariæ*, though beautiful as usual, are all small. A new species of the genus *Crossea* is an acquisition. The only *Solarium* is small.

Fam. Ranellacea, *Troschel.*

Nassaria, *Link.*

Nassaria kampyla, n. sp. (καμπύλος, bent.)

St. 164 a. June 13, 1874. Lat. 34° 13′ S., long. 151° 38′ W. Off Sydney. 410 fms. Grey ooze.

Shell.—Thinnish, porcellaneous, white, ribbed, banded, and tubercled; with a high spire, a blunt rounded apex, rounded whorls, and a contracted rounded base produced into a very one-sided, narrow, sinistrally bent, and reverted snout. *Sculpture.* Longitudinals—there are on each whorl from 13 to 15 rather narrow ribs, which are feeble in the sutures and die out on the base; they are small, sharp, close-set, and regular on the first ordinary whorl; afterwards they become irregular and distant, and on the body somewhat obsolete; at every two thirds of a whorl one of these ribs becomes prominent as a varix, with the old mouth-edge in front: the whole surface is roughened with rather harsh lines of growth. Spirals—there are several distant bands, sharpish on the upper whorls, broad and feebly raised on the last; these rise into low rounded tubercles in crossing the ribs; one of them has a slight tendency to form an angulated shoulder some way below the suture; they extend to the base, but pass over into threads on the snout: the whole surface is further scored by fine, close-set, rounded threads; these are fretted harshly, but the intervening furrows most delicately and sharply by the lines of growth. *Colour* porcellaneous white

below the pale-chestnut surface. *Epidermis* very pale chestnut, thin, somewhat persistent, most delicately hirsute, a minute bristle rising from each of the frettings or minute tubercles formed on the spiral threads by the crossing lines of growth. *Spire* high, narrow, conical. *Apex* globose, ending in a very small depressed tip; its 4 whorls are rounded, smooth, but finely scratched with about six distant spiral lines; they are obtusely but sharply angulated above, and are parted by a narrowly tabulated suture. *Whorls* $8\frac{1}{2}$ in all, rounded, contracted above and below, rather obscurely angulated; the upper whorls are rather high and narrow, the penultimate shortish and broad, the last slightly tumid, with a rounded contracted base, produced into a very lop-sided, longish, narrow, conical, sinistrally bent and reverted snout. *Suture* impressed, irregular, horizontal between the upper whorls, but between the penultimate and the body-whorl very oblique. *Mouth* circularly oval, slightly pointed above and also below, where it runs out into the long, nearly closed, sinistrally bent canal. *Outer lip* semicircular in its curve, projecting thin and sharp in front of the labral varix, patulous except near the body, smooth within, but slightly furrowed by the external spiral sculpture; it is pinched-in at the top of the canal, down the side of which it runs in a pretty straight line. *Inner lip* semicircular, patulous, with a few obscure tubercles in front; it is continuous with the outer lip; its edge is slightly prominent on the body, markedly so on the pillar, with a furrow behind it, and an umbilical chink at the origin of the canal, where it is bent suddenly and broadly over to the right, so as nearly to cover the canal altogether. *Operculum* thin, horny, ovate, being rounded at the sides, a little narrowed behind and subtruncate in front, where at the outer corner is the nucleus, forming the centre of the lines of growth, with which it is rather strongly scored. H. 1·67. B. 0·8. Penultimate whorl, height 0·32. Mouth, height 1 (exclusive of canal 0·6), breadth 0·45.

Operculum of *Nassaria kampyla.*

In this species the change of direction in the suture gives the impression of a bend in the axis, and the twisted look of the shell is increased by the distortion of the snout.

The genus under which to class this form has been selected with much hesitation. *Tudicla* has the snout sometimes distorted to the left, and has (*teste* Kobelt) an operculum with a terminal nucleus, but is characterized by a strong tooth on the pillar and a low spire.

Murex seemed suggested by the peculiarity of shape, by the almost total absence of teeth on both lips, and by the length and straightness of the distorted snout, features more or less present in various species, but especially in *M.* (*Haustellum*) *elegans*, Beck, *M.* (*H.*) *trilineatus*, Reeve. But in all the species of that group the distortion of the snout is, I think, to the right, instead of, as here, to the left. In the end I have followed the advice of Dr. Kobelt, feeling his opinion confirmed by the form of the apex and by the texture of the shell, in both of which points it resembles *Nassaria*. I am not aware that any species of that genus has been described as having an epidermis; but, unless there be cases where it is certain that no epidermis exists, its existence may be taken for granted: its absence is often due to remorseless cleaning of specimens for the market. The operculum is somewhat unlike that of *Nassaria*, and combines the characters of *Purpura*, *Buccinum*, and *Typhis*, though here again ordinary representations are untrustworthy, especially in the case of species whose opercular nucleus is at or near the edge. In these cases the body of the animal gradually separates from the old part of the operculum, which is then apt to be abraded, and thus to present features strangely unlike those of specimens which are young, or which come from deep and quiet water.

Fam. MURICIDÆ, *Troschel*.

MUREX, *Linn.*

1. *Murex* (*Tribulus*) *acanthostephes*, n. sp.
2. *M.* (*T.*) *acanthodes*, n. sp.
3. *M.* (*Pteronotus*) *Cordismei*, n. sp.
4. *Murex* (*Pteronotus*), sp. (n. sp.?).
5. *M.* (*Ocinebra*) *pholidotus*, n. sp.
6. *M.* (*O.*) *pyrrhias*, n. sp.
7. *M.* (*O.*) *pauper*, n. sp.

TYPHIS, *Montf.*

T. phillipensis.

1. MUREX (TRIBULUS) ACANTHOSTEPHES, n. sp. (ἀκανθοστεφής, prickle-crowned.)

St. 188. Sept. 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E. W. of Cape York; off S.W. point of Papua. 28 fms. Mud.

Shell.—Thinnish, ashy white, globose, with a short scalar spire, spinous whorls, a largish smooth waxy irregularly tipped apex (which is quite overtopped by the spines from the outer lip upward), an oval mouth, deeply crenulated outer lip, short rounded base, and a very fine produced almost straight long-spined snout. *Sculpture.* Longitudinals—there are on each whorl 3 narrow

corresponding varices, scarcely visible on the earlier whorls, and chiefly marked on the last by the series of long thin front-furrowed spines which adorn them: of these spines there are 6 (or 7 ?) on the last varix, 6 on penultimate, and 5 on the preceding one; the highest is very little bent, and rises on each whorl high above the apex, being almost parallel to the axis of the shell; the others, which are alternately short and long, are more or less bent, and incline upwards: there is only one spine on each varix of the spire; these varices are prolonged down the snout; and each is armed with about 6 long thin horizontally straight but forward-bending front-furrowed nearly equal spines, between each pair of which in front is a small, fine, procumbent thorn; the system of triple varices begins in the course of the second regular whorl: above this point the shell is scored across by from 10 to 16 scars of old mouth-edges, which at top and bottom of the whorl project into little tubes, hollow, and in front open; the lower row of these tubes is only visible on the first regular whorl, and is gradually buried by the overlap of the suture: between the varices there are no ribs, but only fine discontinuous undulations, with superficial regular puckerings and lines of growth, which behind the lip exhibit fine crowded laminæ. Spirals—there are on the last whorl 3 strongish depressed rounded threads corresponding to the 3 largest spines; corresponding to the smaller spines are smaller threads; between all of these are one or more fine threads parted by shallow furrows wider than they: besides all these the whole surface is scored with very minute, rather distant, and somewhat irregular threadlets; the highest thread, connecting the series of largest spines, forms a strongly angulated shoulder-edge on the upper whorls. *Colour* ashy white with a rufous tinge, which is strongest on the spines and the point of the snout; the apex is waxy and subrufous; the mouth-edge all round is porcellaneous white, with one or two chestnut specks on the outer lip, the largest and brightest being just at the top of the mouth. *Spire* rather low, conical, scalar. *Apex* consists of $2\frac{1}{2}$ rounded, more or less depressedly globose whorls, of which the earliest is always deformed as if crushed; the others are smooth, and are parted by an impressed suture; they terminate abruptly in a patulous and prominent mouth-edge, which has a small sinus at the top. *Whorls* 7, angularly carinated above, and with a sloping shoulder between the suture and the keel; the upper whorls are subcylindrically conical, the last tumid and

rounded, with a very contracted convex base produced into a very long subconical snout, which is flexuous in front, where an old snout-end stands off like a splinter. *Suture* a slightly impressed line in the obtuse angle at the junction of the whorls. *Mouth* oval, with a blunt angle above and another below, where it is produced into the long, flexuous, and almost closed canal. *Outer lip* very equally arched; it rises on the body; its edge contracts, and is cut up into a series of blunt-tipped saw-teeth, the deep and narrow cuts between which run back into the front furrows of the spines; the basal one of these saw-teeth is large, flat, and very prominent. *Inner lip* spreads thinly and widely but indefinitely on the body above; on the base it separates from the body as a thin, prominent, patulous lamina, curving round to the right lower down, leaving behind it a deep chink, which continues as a furrow down the snout, where the labial lamina is bent abruptly over, so as to cover and almost close the canal. H. 3·1 (to point of spines beyond apex 3·6). B. 0·93 (to tips of spines 2·2). Penultimate whorl, height 0·25. Mouth, height 2·65 (excluding canal 0·72), breadth 0·5.

This singularly beautiful species resembles most of all *M.* (*T.*) *aduncospinosus*, Beck; but in that the direction of the spines is different, standing out much more from the axis; the texture and ornamentation of the shell are quite different, the earlier whorls not being ornamented with a double row of hollow squamous spines as here; the spire is in that much higher, the whorls less angulated, and the apex is a minute prefect cone of 3½ whorls. In *M.* (*T.*) *ternispina*, Lam., the earlier regular whorls have somewhat similar hollow squamous spines; but there is but one row of these, and the apex is quite different. *M. tribulus*, L., though at first sight very unlike, has some very strong points of resemblance: it is a bigger, coarser shell, with shorter, fewer, and more massive spines; but the direction of all these agrees pretty closely with those in the 'Challenger' specimen; its spiral threads are enormous compared with those of the other, and are rudely tubercled; yet in neither species are there any longitudinal ribs; though the snout is very short and thick compared with that of *M. acanthostephes*, obliquely scored in connexion with the spines where the other is smooth and much more bent at the point, yet the bend has very much the same character. In *M. tribulus* the whorls are constricted below, which makes the suture dissimilar, yet the general form of the

spire is not unlike. In regard to the apex I am unable to speak with certainty. A specimen of *M. tribulus*, which Prof. v. Martens most obligingly sent me for examination from the Berlin Museum, turned out to have suffered from the effects of cleaning almost as much as those in the British Museum; so far, however, as the apex was recognizable, it seemed to have fewer whorls, and to be somewhat more conical but more amorphous, and the first regular whorls seem to have only one row of squamous tubercles, as in *M. ternispina*, Lam.

2. MUREX (TRIBULUS) ACANTHODES, n. sp. (*ἀκανθώδης*, prickly.)

Sept. 8, 1874. Cape York (Australia), off Albany Island. 3–12 fms.

Shell.—Thinnish, pale rufous, globose, with a short scalar spire, spinous whorls, a minute, regular, conically globose, glossy chestnut apex, an oval mouth, a denticulated and, on the edge, slightly crenulated outer lip, a short rounded base, and a long straightish snout. *Sculpture.* Longitudinals—there are 3 strongish corresponding varices on each whorl; they are marked by short stout diverging front-furrowed spines, whose numbers are probably incomplete (as the specimens are young), but are evidently few; these spinous varices run straight down the snout; between the varices are two tubercled ribs; the first 2½ regular whorls present no distinction between these varices and ribs, but are crossed by about 10 tubercled ribs, on each of which above is a single short hollow spine; besides these are many, faint, very slightly raised, rounded threads. Spirals—there are on the last whorl about 20 narrow, rather raised, rounded, distant threads; others similar appear on the snout, but become obsolete in front, the latter third being glossy and smooth; the upper whorls are bisected by an angular keel, besides which, on the last whorl, there is a blunter keel where the basal contraction begins: both of these keels are accentuated by the tubercles into which they rise in crossing the longitudinal ribs and the spines on the varices. *Colour* dead white with a rufous tinge, which is stronger on the spire, on two faint bands corresponding with the keels, on the spines, and on the glossy point of the snout, where are some rich chestnut stains; the apex is also chestnut. *Spire* low, conical, scalar. *Apex* consists of 3 conically globose, rounded, glossy, chestnut whorls, of which the extreme tip is minute, rounded, and a little bent down and

inserted; they terminate abruptly in a patulous and slightly prominent mouth-edge, which is regularly curved, has no sinus, but has a concave edge. *Whorls* 8; but the shell is not full-grown; the upper ones are angulately carinated in the middle, with a sloping shoulder between the suture and the keel; they are all slightly rounded, with a very faint contraction into the suture; the last is tumid, angularly rounded, with a very contracted convex base produced into a very long snout. *Suture* angulated and slightly constricted. *Mouth* oval, rounded above, pointed below, where it runs into the long, nearly closed, linear, straight canal. *Outer lip* semicircular; its edge, which projects markedly in front of the labral varix, is somewhat cut up by slashes continuous with the furrows of the spines; a basal tooth is somewhat prominent; internally the lip is feebly toothed. *Inner lip* spreads thinly and narrowly on the base, and advances straight down the pillar as a reflexed lamina, which is abruptly turned over to the right to cover the canal, leaving behind it a chink above and a long straight furrow below. H. 1·8. B. 0·6. Penultimate whorl, height 0·13. Mouth, height 1·5 (excluding the canal 0·38), breadth 0·27.

This species is very like *M. Macgillivrayi*, Dohrn, but is certainly distinct. Like that species it has two intervarical ribs; and the texture of the shell and the short spines are similar; but the spiral threads are different, the spire is bigger, broader, and shorter, and that species has none of the hollow squamous spines which ornament the earlier whorls; the embryonic whorls of the apex are a good deal alike; but the cone in *M. Macgillivrayi* is smaller and less regular, its whorls being more rounded and parted by a deeper sutnre. In these respects the apex resembles *M. aduncospinosus*, Beck, from which it manifestly differs widely in other ways. In the hollow squamous spines of the earlier whorls it resembles *M. ternispina*; but the arrangement of these is different, and the embryonic apex of that species is utterly diverse. *M. Cabritii*, Bernardi (Journ. de Conch. vol. vii. 1858, p. 301, pl. x. f. 3), has a considerable general resemblance, but is not angularly carinate above, has not a scalar spire, has a shorter and coarser apex, has 4 (*teste* Bernardi, but his figure and Sowerby, in his 'Thesaurus,' pt. 33, p. 2, pl. cccxciii. f. 137, both in text and figure, say 3) intervarical ribs, and the spirals are much coarser and less sharp.

3. Murex (Pteronotus) Cordismei, n. sp.

St. 162. April 2, 1874. Lat. 39° 10′ 30″ S., long. 146° 37′ E. Off East Moncœur Island. Bass's Straits. 38–40 fms. Sand.

Shell.—Thinnish, pale, fusiform, biconical, scalar, with three foliated and spinous varices, an elongated spire, a papillary tip, tubercled rounded whorls, an elongated scarcely constricted base, and a large flat snout. *Sculpture.* Longitudinals—there are on each whorl 3 foliated varices, which at the corner of the shoulder rise into a semitubular upturned and slightly reverted spine; they run out on the snout: between each two varices and nearly on a level with the spines are 3 large prominent rounded tubercles, which are somewhat produced longitudinally; the lines of growth are very slight. Spirals—besides the carination caused by the line of tubercles and spines, there is on the base a slight angulation. *Colour* pale. *Spire* rather high, conical, scalar. *Apex* consists of two largish cylindrical whorls, of which the top is angulated and obliquely truncated, and the extreme tip inserted. *Whorls* 6, of slow increase, feebly angulated, with a sloping shoulder; the last is slightly tumid and elongated, with a slightly constricted base produced into a rather large flattened snout. *Suture* linear, a little impressed. *Mouth* oblong, not patulous, rounded above, where to the right a canal runs out into the labral spine; it is pointed below, where it is prolonged into the longish canal. *Outer lip* well arched, prominent, thin. *Inner lip*—above it is continuous with the outer lip; its course is semicircular; on the body it expands with a thin edge, which in front, near the opening of the canal, rises in a thin lamina, and is then bent over to the right to cover the canal; behind it to the left the pillar is scored with the projecting laminæ of the old canal-ends, which connect themselves with the longitudinal varices. H. 0·42. B. 0·2. Penultimate whorl, height 0·06. Mouth, height 0·25 (without the canal 0·11), breadth 0·07.

This little shell is very like a *Typhis*; but its spines are not pervious.

4. Murex (Pteronotus), sp. (*M. dentifer*, n. sp.?).

St. 194. Sept. 29, 1874. Lat. 4° 34′ to 4° 31′ S., long. 129° 57′ E. 200–360 fms. Volcanic detritus.

This is a massive full-grown (?) shell, which in my list I have called *M. dentifer*, as a new species, but which is in too bad condition for detailed description. It certainly is not in the

British Museum, nor is it figured so far as I know. It is not unlike in shape to the immature shell of *M. imperialis*, Swains., from California; but its snout seems to have been long and was certainly narrow. It has 3, not 5 varices (which are rounded, high, narrow, and continuous from whorl to whorl), with 4 (or on the last segment 6) biggish rounded ribs between the varices; the old mouth-edges on the front of the varices are not like saw-teeth, but smooth and continuous; the mouth is small, oval, not large; the lip is not internally thickened; and the surface is marked with regular strong spiral threads and with fine regular lines of growth, and is not squamously fine-grained. The outer lip is scored with long, sharpish, but fine teeth; the inner lip is closely set with teeth, which are short and strong on the pillar, feeble and a little longer on the body, with a round tubercle at the very top; there is a broad glaze on the body, which separates and stands out as a strong lamina on the pillar, with a deep umbilical cleft behind it.

5. MUREX (OCINEBRA) PHOLIDOTUS, n. sp. (φολιδωτός, scaly.)

Sept. 8, 1874. Flinders Passage, Cape York, Torres Straits. 7 fms.

Shell.—Strongish, biconical, subscalar, with a shortish spire, a small apex, and a short twisted snout. *Sculpture.* Longitudinals—there are no true varices; but there are 7 rather tumid ribs, which run continuously from the apex to the snout with a slight inclination to the left; they are parted by broader furrows, which are shallow and rounded: the whole surface is covered by sinuous laminæ which rise into vaulted scales; these laminæ are about the hundredth of an inch apart, and their interstices are scored with somewhat irregular wrinkles. Spirals—there are strong round threads, with broader flat furrows, about 6 on the penultimate and about 15 on the last whorl; it is in crossing these threads that the longitudinal laminæ rise into vaulted scales. *Colour* white, but the specimens are bleached. *Spire* rather short, conical. *Apex* small. *Whorls* about 8; they are conical above, subcarinated about the middle, and cylindrical below; the last is slightly ventricose, with a conical contracted base, produced into a short, broad, flat, reverted snout, which is twisted and obliquely cut off at the point. *Suture* slightly and angularly impressed. *Mouth* oval, with a small channel above and pointed below, where it runs into the canal, which is short, open, direct, and a little turned to the right. *Outer lip* patulous,

well arched, thin on the edge, strengthened at a little distance by a varix, with 5 or 6 long, narrow, distant teeth within. *Inner lip* short and straight across the body, where it spreads thinly and indefinitely; it is angulated at the base of the pillar, which is long and very straight, and has in front 2 or 3 inconspicuous tubercles; the callus-edge is straight and sharply defined; and there is a slight umbilical depression in front between it and the cord, which twists round the point of the snout. H. 0·56. B. 0·3. Penultimate whorl, height 0·1. Mouth, height 0·36, breadth 0·17.

This species is not well represented in the specimens brought home. It somewhat resembles our British *M. aciculatus*, Lam., but is a little larger, shorter, broader, more angulated, and conical. *M. Brazieri*, Ang., has the upper whorls higher, and the last much more tumid.

6. MUREX (OCINEBRA) PYRRHIAS, n. sp. (πυῤῥίας, red-head.)

St. 75. July 2, 1873. Lat. 38° 38′ N., long. 28° 28′ 30″ W. Fayal, Azores. 450 to 500 fms. Sand.

Shell.—Thinnish, white, oblong-fusiform, subscalar, with a moderate spire, a small chestnut-coloured tip, a short rounded base, and a small snout. *Sculpture.* Longitudinals—there are no varices; but somewhat narrow, rounded, tumid ribs, about 9 on each whorl, run continuously from the apex to the point, but become very slight on the base; their intervening furrows are broad, shallow, and rounded: the whole surface is scored by very small lamellæ, which rise in vaulted scales; in the minute interstices of these there are very slight puckerings. Spirals—there is an angulation about the middle of the whorls, which on the last is slight; this angulation is marked on the earlier whorls by a spiral thread, which rises into a little knob on the ribs; on the last whorl the whole surface (except just below the suture) is covered with close-set equal irregular rounded threads, on which the longitudinal lamellæ rise into vaulted scales; the point of the snout is a twisted cord scored with the old canal-scars. *Colour* yellowish dead-white, with a ruddy chestnut tip. *Spire* rather high, conical, subscalar. *Apex* chestnut, turbinated, small, blunt-pointed, consisting of 3½ rounded polished whorls, which end with a distinct, prominent, reverted and sinuated edge. *Whorls* 8 to 9 in all; they are conical and shouldered above, angulated about the middle, below which they are cylindrical; the last is scarcely angulated, rather small, rounded, with a short contracted base produced into a small equal-sided snout, which

is nicked at the point. *Suture* very slight, linear. *Mouth* oblong, pointed and channelled above, and still more below, where there is a rather broad, open, oblique canal. *Outer lip* scarcely patulous, well arched, thin on the edge; there is a slight varix within, and 5 very insignificant tubercles for teeth. *Inner lip* forms a continuous curve across the body and down the pillar, which is obliquely cut off in front; the labial callus is a little thickened at the top, and is narrow, with a well-defined edge; there are one or two feeble tubercles on it in front; behind the callus at the point is a very slight and superficial umbilical depression. H. 0·46. B. 0·25. Penultimate whorl, height 0·09. Mouth, height 0·26, breadth 0·11.

This is an inconspicuous little shell, somewhat more angular and conical than *M. aciculatus*, Lam. The spire is not unlike that of *M. Edwardsii*, Payr.; but the last whorl is much smaller than in that species, and the whole sculpture is different and much more delicate. It most of all resembles a species I found in Madeira, but which is yet undescribed.

7. MUREX (OCINEBRA) PAUPER, n. sp.

Oct. 6, 1874. Amboyna. 15 to 20 fms.

Shell.—Strong, oblong, biconical, with a high, subscalar, fine-pointed spire, and an elongated base produced into a short, flat, slightly twisted, and reverted snout. *Sculpture.* Longitudinals—there are rounded, tumid, nearly straight ribs, 9 on the last and increasingly more on the earlier whorls; they originate at the suture, and extend to the snout; their tumidity, which is most marked at the periphery, angulates the whorls: the surface is scored by fine lamellæ, which run continuously and rise into vaulted scales; between these lamellæ there are fine puckerings. Spirals—there are rounded threads parted by furrows of the same breadth as the threads, but in which often a smaller thread occurs; the front of the snout has a strongish twisted cord scored with the old canal-edge scars. *Colour*: the specimen is bleached. *Spire* high, conical, subscalar. *Apex* small. *Whorls* 7 to 8; they are conical and shouldered above, bluntly angulated and cylindrical below. *Suture* a very slightly impressed line in the broad rounded furrow of the whorls' meeting. *Mouth* oblong to subrhomboidal, pointed and slightly channelled above; the canal in front is open and somewhat curved. *Outer lip* thickened by the external varix, but bevelled off to a narrow edge, with 7 longish small teeth within; not patulous; it is flatly arched, and is at

the canal angulated. *Inner lip* short, arched, expanded, with 2 small tubercles in front, and a very slight umbilical depression behind it; obliquely and curvedly cut off by the canal. H. 1. B. 0·52. Penultimate whorl, height 0·2. Mouth, height 0·6, breadth 0·27.

This species is represented by one specimen, in poor condition. It is somewhat like the young, or even some of the elongated forms of *M.* (or *Pseudomurex*) *Meyendorfii*, Calc.; but it is more attenuated, with a less-impressed suture, longer body-whorl, stronger and straighter ribs, and much more delicate spirals.

TYPHIS PHILLIPENSIS, n. sp.

St. 161. April 1, 1874. Lat. 38° 22′ 30″ S., long. 144° 36′ 30″ E. Off the entrance to Port Phillip, Melbourne. 38 fms. Sand.

Shell.—Thinnish, buff-coloured, oblong-fusiform, biconical, scalar, with a shortish spire, a papillary tip, variced and hollow-spined whorls, a contracted base, and a long, fine, reverted and dextrally bent, closed snout. *Sculpture.* Longitudinals—there are on each whorl about 9 ribs, which are alternately rounded and sharpish; the latter are varices, which on the last whorl run out to the point of the base; they bear 5 upturned and reverted, almost twisted, hollow spines, which are open in front; the intermediate ribs are very slight in themselves, but bear each at the periphery the straight tube of the genus (of which only the last opens through the shell), and below this, in the line of the suture's course, a prominent round-topped tubercle; the intervals are hollow and broader than the ribs: the surface is scored with sharp lines of growth, which are much distorted by the spines. Spirals—there is an obscure angulation of the shell at the upper row of tubercles; there are faint microscopic scratches on the whole surface. *Colour* buff, with obscure dark-chocolate spots at the suture, the periphery, and toward the point of the base; the spines and mouth are whiter; there is a kind of chalky bloom on the surface. *Spire* rather short, conical, scalar. *Apex* pale, smooth, papillary, blunt, rather large, consisting of two rounded cylindrical whorls, divided by a deep and very oblique suture; just above the first mouth-edge is one of the hollow tubes of the genus. *Whorls* 6, of slow increase, angulated, with a flat horizontal shoulder above, below which they are cylindrical; the last is slightly tumid, feebly bicarinated, with a contracted conical base, which is produced into a broad flat snout, drawn out to the

right into a long, fine, scarcely reverted straight tube. *Suture* very horizontal, much interrupted, slightly impressed at the bottom of the angle in which the whorls meet. *Mouth* very perfectly oval, slightly pointed in front, where there is a minute cleft in the prominent lip-edge; but beyond this the canal is entirely closed. *Outer lip* projects quite straight as a thin prominent edge considerably in advance of the last varix. *Inner lip* exactly similar to the outer lip, with which it is continuous above, and from which it is only separated below by the minute cleft of the canal; behind it is a strong furrow, bordered to the left on the body by one of the varices, and in front by the lines of vaulted spines of the old canal-ends. *Operculum* pointedly ovate, has a small, somewhat elongated, anterior terminal apex, and is scored across outside with curved, thin, imbricated, rather distant lamellæ. H. 0·72 (length of canal 0·3). B. 0·35. Penultimate whorl, height 0·08. Mouth, height (without the canal) 0·16.

This pretty little species is very like *T. Cleryi*, Petit, from New Zealand; but in that the embryonic apex is finer and more prominent, the spire is higher, the base is more inflated, the whole last varix is much stronger, and on the base the varices have no hollow spines as in the 'Challenger' species. *Typhis duplicatus*, Sow., has the embryonic apex very similar, but is higher and finer in the spire, has only three regular rows of hollow spines, and these do not extend to the base. *Murex cirrosus*, Hinds, is very like in form and general aspect, but has strong spiral threads on the whorls, is more contracted in the base, and has an open canal. Mr. Edgar Smith had the kindness to compare for me the 'Challenger' species with *T. Yatesi*, Crosse; and writes:—"In your species the whorls are not so constricted at the base, and the tabulation or upper slope is oblique. In *T. Yatesi* they are much constricted, and the tabulation is horizontal. The number of varices is the same; but the ornamentation of them is different. Crosse describes his 'peculiariter cristato-denticulatis,' whilst your's have hollow conical spines or hooks. The hollow tubes, too, in your shell are directed nearly at right angles to the axis; in *T. Yatesi* they are obliquely upward-inclined. Beneath these in yours I see a small prominence, which is not present in the other. The type, however, is a very worn shell; and it is possible that in fine specimens these prominences might exist, and the varices be more spinous; but the shape of the whorls and the direction of the tubes would remain the same."

SCALARIIDÆ, *Keferstein*.

SCALARIA, *Lam*

1. *S. tortilis*, n. sp.
2. *S. dentiscalpium*, n. sp.
3. *S. acus*, n. sp.
4. *S. funiculata*, n. sp.

CROSSEA, *A. Ad.*

C. striata, n. sp.

1. SCALARIA TORTILIS, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. N. of Culebra Island, St. Thomas, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Very long, with numerous small rounded whorls, broadish, rounded distant ribs, and close spiral threads, impressed suture, and a broad, square, smooth base defined by a strong spiral thread. *Sculpture.* Longitudinals—There are on each whorl 14 rather remote rounded ribs; they slightly diminish in number and remoteness up the spire; they cross the whorls with a very slight trend but straight course toward the right; they do not extend to the base, which is quite plain but for slight hair-like lines of growth. Spirals—there are about 9 or 10 close-set very little raised threads on each whorl; that defining the base is strong, and can be traced just above the suture up the spire. *Colour* white. *Spire* high and narrow, conical. *Apex* broken. *Whorls*—10 at least remain below the embryonic shell; they are well rounded, and of very slow increase both in height and in breadth. *Suture* deeply impressed by the contraction of the whorls above and below. *Mouth* broken, but apparently very round and oblique, a little angulated at the basal keel. *Inner lip* slight, very thin on the body, slightly reverted on the pillar. H. 0·42. B. 0·1. Penultimate whorl, height 0·06. Mouth, height 0·07, breadth 0·07.

This species has some resemblance to *S. varicosa*, G. O. Sars (S. Wood?), but is much narrower, with smaller and more numerous whorls; and the base is much squarer, and is not contracted. It extremely resembles *Cerithium costulatum*, Möll., but is a larger shell, and under a superficial resemblance the whole sculpture, both longitudinal and spiral, is quite different.

2. SCALARIA DENTISCALPIUM, n. sp.

St. 187. Sept. 9, 1874. Lat. 10° 36′ S., long. 141° 55′ E. Near Cape York, Torres Straits, N. Australia. 6 fms. Coral-sand.

Shell.—Small, extremely long and sharp, most delicately closely and sharply ribbed and spiralled, with rounded whorls and base and an impressed suture. *Sculpture.* Longitudinals—the whorls are crossed by an immense number of minute, sharp, very oblique

riblets, whose course is from right to left; they extend to the whole base; at irregular intervals one of these swells to a varix. Spirals—there are similar, but smaller, more numerous, and closer-set spirals, over which the longitudinal ribs rise. *Colour* porcellaneous white. *Spire* high, narrow, conical. *Apex* consists of 4½ hardly rounded, glossy, conical whorls, parted by a scarcely impressed suture, and rising to a very minute rounded tip. *Whorls* 10 in all, convex, of regular increase; the last is small, with a well-rounded base. *Suture* rather deeply impressed, oblique. *Mouth* encircled with a strong varix, a little oblong, slightly oblique in both its planes. *Outer lip* well arched, rounded, contracted above, patulous in front. *Inner lip* narrow, thick, continuous with the outer lip. H. 0·16. B. 0·05. Penultimate whorl, height 0·02. Mouth, height 0·04, breadth 0·03.

This is a peculiarly narrow species, of a rather remarkable style of sculpture.

3. SCALARIA ACUS, n. sp.

St. 73. June 30, 1873. Lat. 38° 30′ N., long. 31° 14′ W. W. of Azores. 1000 fms. *Globigerina*-ooze. Bottom temp. 39°·4 F.

Shell small, compact, long, sharp, solidly ribbed, deeply sutured, with no spiral markings whatever, but a strong thread on the rounded base. *Sculpture.* Longitudinals—there are on the last whorl about 17, and on the first regular whorl about 15, strong, raised, rounded ribs, which cross from suture to suture in the line of the axis, and extend, though less strongly, to the base. Spirals—there are none except one sharpish thread, which comes out exactly at the upper corner of the mouth, and encircles the base. *Colour* ivory-white. *Spire* high, narrow, conical. *Apex* consists of three brownish-yellow, glossy, broad, cylindrical whorls, of which the first is very short and rounded, the second short and slightly conical, and the third high and cylindrical; they have very fine, microscopic, hardly raised, flexuous, longitudinal threads, and still finer spirals. *Whorls* 12 in all, very much constricted at the suture both above and below, and somewhat flattened in the middle; after the apex they are of very slow and regular increase; the last is smallish, with a rounded base, within the contraction of which lies the basal hread. *Suture* wide and deeply impressed, oblique. *Mouth* broken. H. 0·22. B. 0·06. Penultimate whorl, height 0·037. Mouth, height 0·044, breadth 0·04.

There is another *Scalaria* from St. 122, off Pernambuco, 350 fms., which extremely resembles this, but is quite distinct, being

spiralled between the ribs, and having a very small, conical, blunt embryonic apex, consisting of from 4 to 5 whorls.

4. Scalaria funiculata, n. sp.

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Small, rather stumpy, with strongish pinched-out ribs, and compact crimped spirals; the base is broad, flat, and encircled with a strong spiral thread. *Sculpture.* Longitudinals—on the last whorl there are about 10, on the earlier whorls rather more, strongish ribs, which have broad bases and narrow crests; they run very straight down the spire, but have each a minute twist to the right at the top, and almost inappreciably to the left at the bottom of the whorls; they do not extend to the base. Spirals—the whole surface is covered with small, flattened, close-set threads, only separated by extremely minute scratches; these threads are finely crimped, which gives them the rope-like appearance under the microscope from which the name of the species is derived. *Colour* darkish. *Spire* high, conical, with a broadish base. *Apex* broken. *Whorls*—8 to 9 remain; they are regularly convex; the last is broadish, short, with a broad square flat base defined by a strongish thread round the outside. *Suture* narrow, impressed, rather oblique. *Mouth* perfectly round. *Outer lip* prominent beyond the last rib, rounded, blunt. *Inner lip* very short on the body, which it crosses with a small shelf, of which there are traces all round the mouth within the outer edge. H. 0·23. B. 0·085. Penultimate whorl, height 0·037. Mouth, height 0·04, breadth 0·04.

I have a *Scalaria* of my own dredging at Madeira which extremely resembles this species, but is distinct. It is narrower, the crimping of the spirals is finer, the longitudinal ribs extend to the base, which is rounded and has the basal thread much more within the contraction of the basal rounding than is the case here.

Crossea, *A. Ad.*

Crossea striata, n. sp.

St. 187. Sept. 9, 1874. Lat. 10° 36′ S., long. 141° 55′ E. Near Cape York, N. Australia. 6 fms. Coral-sand.

Shell.—Very small, white, turbinate, spirally striated, with a subscalar spire, a minute rounded apex, tumid last whorl, and a small strongly bordered umbilicus. *Sculpture.* Longitudinals—there

are microscopic lines of growth which gather into puckers below the suture. Spirals—there are furrows broadish and square-cut, parted by flat raised surfaces of about twice their breadth; these extend to below the periphery, but not to the base, the most of which is smooth; round the umbilicus is a high raised thread, which relatively to the size of the shell is enormous. *Colour* porcellaneous white. *Spire* raised, subscalar. *Apex* very small, tabulated, with the extreme tip just visible. *Whorls* 4, well rounded, a very little tabulated below the suture; the last is tumid. *Suture* strongly marked, but hardly impressed. *Mouth* round, but a little gibbous, bluntly pointed above. *Outer lip* scarcely patulous, well arched, thin. *Inner lip* regularly curved from the corner of the mouth to the point of the pillar, which is arched, with a thin inner edge parting the mouth from the umbilicus and joining the outer lip, while round the umbilicus twists the strong marginal cord which runs out into a strong blunt tooth at the tip of the pillar. *Umbilicus* deep, small but strongly marked. H. 0·06. B. 0·05. Penultimate whorl, height 0·01. Mouth, height 0·03, breadth 0·028.

This species differs from *C. bellula*, A. Ad., in being higher, with a smaller and more scalar spire, and a more elongated base. Its smaller size, higher and narrower form, striated sculpture, and strong projecting pillar-point distinguish it markedly from *C. concinna*, Ang., from Port Jackson, Sydney.

Fam. SOLARIIDÆ, *Keferstein*.

Gen. SOLARIUM, *Lam.*

SOLARIUM (TORINIA) ROSULENTUM, n. sp.

St. 163 A. June 3, 1874. Lat. 33° 51′ 15″ S., long. 151° 22′ 15″ E. Off Port Jackson. 35 fms. Rock. Bottom temperature 63° F.

Shell smallish, ruddy yellow, with bright crimson spots, flat, with a slightly raised conical and scalar spire, rounded carinated whorls, and a large, open, pervious umbilicus defined by a sharp thread and rayed with sharp diverging lamellæ. *Sculpture.* Longitudinals—the surface of the shell is beset with small, close, procumbent lamellæ; these below the suture and in the umbilicus are much rarer and more prominent than elsewhere. Spirals—there are sharpish rounded spiral threads on all the whorls; those on the earlier whorls are three or four, and are subequal;

on the last there are above the periphery about four larger, with smaller ones between, while on the base they are numerous, both without and within the umbilicus ; one in particular in the middle of the base is strong, and another, within the funnel, is nearly as much so ; these spirals are faintly crossed by the longitudinal lamellæ ; but within the umbilicus the lamellæ form minute spines or tubercles on the crests of the spirals. *Colour* a cindery yellow with a ruddy tinge, and flecked above, especially on the highest spiral, with brilliant little crimson spots*; the upper part of the spire is bright yellow, the apex pale. *Spire* depressed, conical, scalar. *Apex* rounded, polished, the tip scarcely prominent; the embryonic tip seems, as usual, introverted. *Whorls* 5, of very gradual and regular increase, with a flat, horizontal or slightly sunken shoulder below the suture. *Suture* distinct, being angulated and a very little impressed. *Mouth* round, very oblique, small. *Outer lip* thin, very slightly patulous, with a very feeble white callus within. *Inner lip* has a very short attachment to the body, is rounded, and a little patulous. H. 0·16. B. 0·24. Penultimate whorl, breadth 0·05. Mouth, height 0·09, breadth 0·09.

This very pretty little species is not like any other I know, and rather recalls in form some of the *Solariella* group of *Trochus*; but the mouth, inner lip, texture of shell, and apex are unmistakably those of *Solarium*. There are in this specimen, on the last whorl especially, some minute stumpy setæ, which are probably embryonic seaweed. They are too irregularly arranged to make it likely they should be traces of any epidermis.

* These suggested the name.

INDEX.

NOTE. The Index to Mr. E. J. Miers's "Revision of the Family Idoteidæ" was issued along with the paper, and will be found at pp. 86–88. In the present index no references are made to the subfamilies, genera, species, and synonyms contained in Mr. Miers's index as above quoted.

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